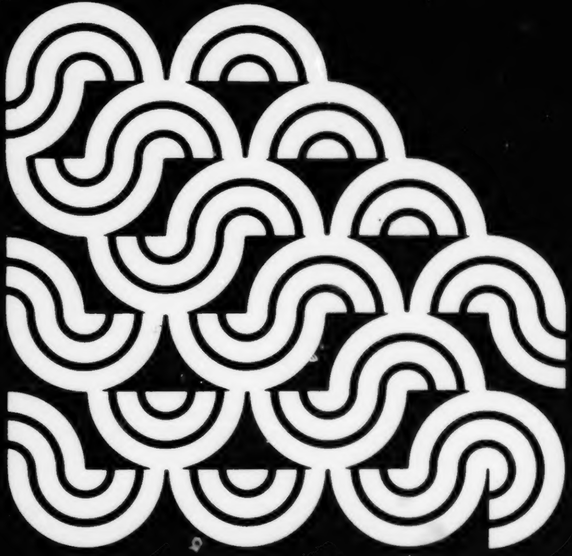
Rate and Cost Analysis of For-Hire Trucking:

Provincial Comparisons

Garland Chow



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RATE AND COST ANALYSIS OF FOR-HIRE TRUCKING: PROVINCIAL COMPARISONS

Garland Chow

Faculty of Commerce
The University of British Columbia

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The analysis and conclusions of this study do not necessarily reflect the views of the Department.

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FOREWORD

This examination of for-hire trucking was undertaken as one of several research contributions of Consumer and Corporate Affairs Canada to an Interdepartmental (Transport Canada, the Canadian Transport Commission and Consumer and Corporate Affairs) reference on regulation/competition in transportation.

Because trucking in Canada is not a homogeneous industry, the author has segmented carriers according to institutional and economic characteristics in order to assess the impact of entry regulation on trucking performance.

Results of the study reveal significant differences in the performance of motor carriers operating in the unregulated environment of Alberta, compared with the entry-regulated provinces of Quebec and Ontario. Both rates and costs decline from Ontario to Quebec to Alberta; yet profits are not noticeably higher in the selected entry-regulated provinces.

On this evidence, the author concludes that higher trucking rates in Ontario and Quebec are required to cover the higher costs -- incuding those imposed by regulation -- in providing trucking services comparable to those in unregulated Alberta.

A principal objective in the Research and International Relations Branch of the Bureau of Competition Policy is to prepare policy-oriented studies in the fields of competition policy and industrial organization to contribute to informed discussion and effective policy formulation. This study makes a substantial contribution to the achievement of that objective.

D. McKinley
Director
Research and International
Relations Branch

SUMMARY

1. This study observed a significant difference between the performance of motor carriers operating in the totally unregulated environment of Alberta and the performance of motor carriers operating in the entry-regulated environments of Ontario and Quebec. Specifically, the study confirms the provincial ranking of carriers in terms of rates earned on general freight observed in previous studies: rates decrease from Ontario to Quebec to Alberta. In addition, provincial carrier costs follow the same pattern. Since there is no evidence suggesting extremely higher profit earnings in the regulated provinces, it follows that higher rates in Ontario and Quebec are necessary to pay for the higher costs incurred in producing trucking services comparable to those provided in Alberta.

2. Traffic characteristics such as the average shipment size and length of haul, and input prices such as wages were specifically accounted for in the models utilized to represent the cost behaviour of the carriers studied. The focus on general freight carriers minimized the influence of traffic mix. Two plausible explanations of the remaining cost differences are the traffic conditions facing the carriers and the regulatory environments of the three provinces studied. Although there is no direct evidence available about the traffic conditions in each province, the analysis of utilization levels indirectly suggests that Ontario carriers are not at any significant disadvantage with regard to this factor. On the other hand, we are sure of the regulatory environments associated with different levels of performance.

3. Inclusion of the utilization measure in the estimation of provincial cost performance did not alter the relationships observed in (1) but did reduce the strength of the relationship.

4. The Canadian trucking industry is not a single homogeneous entity with regard to either regulatory controls or economic characteristics. This study found it necessary to segment carriers by regulatory and economic boundaries to appraise the effects of regulation effectively. It also found significant differences in cost behaviour between truckload (TL) and less-than-truckload (LTL) carriers and between common and contract carriers. Subsequently, it is observed that the LTL segment of Ontario trucking exhibits greater than average (for all Ontario carriers) disadvantages in costs and rates relative to Alberta costs and rates.

5. The observations of this study, to the extent that they be used as input in regulatory policy decisions, are relevant to the evaluation of the relative advantages of entry regulation (without strict rate regulation) versus no regulation. A comparison of the benefits or costs of both rate and entry regulation relative to no regulation is not analyzed.

6. A major constraint in improving this line of analysis is the scarcity of data on traffic lane characteristics. The natural volume and balance of traffic facing a carrier and influencing its efficiency is not directly controlled by public policy. There is a need to identify how such exogenous factors affect performance and how they vary between provinces.

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INTRODUCTION

The proper mix between market forces and economic control as regulators of the performance of the motor freight industry is a subject of intense debate and concern. The provinces of Ontario and Alberta have recently investigated the effects of economic regulation on the structure and performance of trucking within their respective jurisdictions. The need for regulation of interstate trucking in the United States has been severely questioned by economists since its inception in 1935 and "deregulation" legislation was recently passed (Motor Carrier Act of 1980). The legislative arm responsible for the administration of economic regulation in the United States, the Interstate Commerce Commission, has embarked on its own internal program of administrative deregulation. Finally, several states are considering or have implemented deregulation of trucking within their jurisdictions.

The trucking component of the Canadian transportation system is not influenced by federal government policies toward regulation. Extraprovincial trucking falls under the jurisdiction of the federal government under Part III of the National Transportation Act, but this part of the Act has not been implemented. Therefore, the authority to regulate extraprovincial trucking has been delegated to the provincial motor carrier boards with the stipulation that it is controlled in the same way as is intraprovincial trucking. Presently, regulation of intraprovincial trucking varies widely among the provinces with regard to the type, severity and applicability of regulations. Inasmuch as promotion of competition is one of the basic principles of capitalistic economies, there is a need to examine the performance of the trucking industry and assess the influences of these different regimes of regulation. Such an analysis would help determine the proper direction of federal policies over extraprovincial trucking necessary to improve the efficiency of the national trucking system.

The purpose of this study is to estimate trucking performance and make inferences about the influence that regulation has on this performance. Chapter I briefly reviews the previous research relevant to this analysis and the basic tenets of this study. In Chapters II through V, the analysis conducted in this study is developed and the results are displayed. The conclusions and implications which emerged from the analysis are summarized in Chapter VI.

Chapter I

PREVIOUS ECONOMETRIC ANALYSES

The comparative approach has been utilized in a number of attempts to measure and evaluate the performance of motor carriers in Canada. Widely cited analyses include the studies performed by Sloss, McLachlan, Palmer, Maister, Boucher, and McRae and Prescott.[1]

Such a method is feasible because the significant differences in regulatory control exerted by the provinces provide an economic laboratory in which the effects of regulation can be explored. The previous studies are similar in that they focus primarily on the rate level (measured by revenue per ton-mile) as the measure of performance. They differ in the following respects:

1. functional form of variables,
2. types of explanatory variables used,
3. level of aggregation of the unit of observation,
4. classification of economic regulation.

---

[1] J. Sloss, "Regulation of Motor Freight Transportation: A Quantitative Evaluation of Policy," Bell Journal of Economics and Management Science 1, no. 2 (Autumn 1970), pp. 327-66; D.L. McLachlan, "Canadian Trucking Regulations," Logistics and Transportation Review 8, no. 1 (1972), pp.59-81; J. Palmer, "A Further Analysis of Provincial Trucking Regulation," Bell Journal of Economics and Management Science 4, no. 2 (Autumn 1973), pp. 655-64; D.H. Maister, "Regulation and the Level of Trucking Rates in Canada," in Motor Carrier Economic Regulation (Proceedings of a workshop conducted by the Committee on Transportation, Assembly of Engineering, National Research Council, in cooperation with the Transportation Center of Northwestern University, Washington, D.C., 1978a); id., "Regulation and the Level of Trucking Rates in Canada: Additional Evidence," Transportation Journal 18, no. 2 (Winter 1978b), pp. 49-62; M. Boucher, Economic Analysis of Regulations Governing the Trucking Industry in Quebec, Canadian Transport Commission, Research Report no. 20-79-11 (Ottawa, 1979); J.J. McRae and D.M. Prescott, The Effects of Economic Regulation on the Canadian Common Carrier Industry (Centre to Study Inflation and Productivity, Economic Council of Canada, April 1979).

The latter two differences are particularly significant. Until recently, comparative studies employed highly aggregated units of observation: provinces, broad commodity groups by province, broad commodity groups by major traffic lane. Such studies have been highly criticized, indeed by the author of two of the aggregated studies of this sort.[2] Justifiably, the heterogeneity of the trucking industry and its products make aggregated comparisons hazardous when such heterogeneity is related to provincial location. Furthermore, aggregated data frequently does not supply enough information to conduct an adequate study given the heterogeneity in the trucking industry and in the operating environment.

The most recent attempts to measure regulation's impact on rates utilized highly disaggregated shipment data. This was made possible through the availability of The For-Hire Trucking Origin and Destination Survey (TOD) which contains rates, weight, distance, type of commodity and other characteristics of the sample shipments. The use of this additional information, either as explanatory variables or as aggregation criteria, reduced many of the previous criticisms of the comparative approach.

Despite the progress made in recent studies of Canadian trucking performance, several interesting issues remain unresolved. The statistical sources utilized in previous studies allowed only the use of the rate level as a measure of performance. Such a measure may be considered an overall (net) indicator of both allocative and technical efficiency. Rates could be excessive because regulation fosters a monopoly situation in which high rates are protected from competitive pressures. On the other hand, high rates may reflect high costs that result from operating inefficiencies caused directly or indirectly by regulation. Similarly, the source of low rates under regulated conditions could be suppressed profits or low costs. The separation of the impact of regulation on various aspects of economic efficiency requires knowledge of the cost of producing a product as well as the rate. Cost data is not available at the shipment level but is available at the firm level of aggregation.

Another problem with the previous studies is that many factors that affect performance are firm specific and cannot be analyzed at higher or lower levels of aggregation. For example, scale economies, product diversity and labour rates are more effectively associated with the firm than with shipments.

---

[2] See Maister, "Regulation and Trucking Rates," pp. 223-25.

All of the previous studies differ significantly in their treatment of economic regulation. The Sloss (1970), McLachlan (1972) and Palmer (1973) works all dealt with trucking performance between the years 1958 and 1963, but each study classified the provinces differently with respect to which ones are considered nonregulating provinces in addition to Alberta. Maister (1978a, 1978b) and McRae and Prescott (1979) considered four separate regulatory structures reflecting different combinations of the degree of entry and rate control. Boucher (1979) returned to the dichotomous classification of provinces.

The importance of properly treating regulation is demonstrated by comparing the Boucher and McRae-Prescott conclusions which deal with trucking performance over roughly the same time period. McRae and Prescott observe that provincial prices of trucking do differ. For the majority of the commodity groups, the lowest- to highest-priced provinces were grouped in the following order: Manitoba and Saskatchewan, Alberta, British Columbia (B.C.) and Quebec, and Ontario. Boucher observes no statistical differences in prices between regulated and unregulated provinces. However, he classifies Quebec, Manitoba, Saskatchewan and B.C. as regulating provinces, and Ontario, Alberta, Nova Scotia and New Brunswick as nonregulating. If the McRae and Prescott observations have any validity, then the Boucher observations could easily be the result of averaging the lowest costs of Manitoba and Saskatchewan with the next to highest costs of Quebec and British Columbia, and averaging the highest costs of Ontario with the next to lowest costs of Alberta! Thus, the aggregation issue is relevant to the treatment of regulation as well as the unit of observation.

The treatment of regulation is improved by defining more than two regulatory situations as Maister, and McRae and Prescott have done. Indeed, one could define each province as having distinct regulatory structures and make pairwise comparisons. This was simply not possible in the early studies where the unit of observation was "provincial performance in a given year." Consequently, to quantitatively compare two provinces, an eight-year time series of provincial performance in each province would be required to produce 16 observations; such data, however, was not available.

The potential treatment of regulation as being distinct for each province or for more than two groups of provinces (regulating and nonregulating), serves to minimize but not eliminate the problem of capturing the true reality of regulation. A deeper problem arises because regulation is heterogeneous within a province as well as between provinces. Every regulating province defines various classes of carriers and both de jure and de facto regulation vary between these classes. For example, dump trucking was not regulated in Ontario during 1975, and there is evidence that it has remained substantially unregulated in practice since regulations were passed.[3]

In Quebec, different regulatory requirements are placed on general transport permit holders in contrast to bulk transport permit holders. Consequently, it is important to recognize differences in regulation within a province as well as between provinces.

This research utilizes the comparative approach at the firm level of aggregation. As noted by the remarks above, this is more than a mere compromise between the highly aggregated and highly disaggregated research efforts in the past. Performance may be measured by rates, costs or profits. Rates and costs are measured as total revenue and total cost while profits may be measured by the operating ratio (operating expenses/operating revenues), the rate of return on investment or equity, or net profits (total revenues minus total cost). The revenue of a carrier can be viewed as the rate paid for a given quantity of trucking service of a given quality. Two carriers producing identical levels of output and similar types of service should charge the same rate (generate the same total revenue) and incur similar resource costs of production. Differences in performance can be attributed to a variety of factors including regulation. An econometric model would seek to determine the importance of individual factors.

Analysis at the firm level of aggregation also permits an improved treatment of regulation. First, the larger number of observations available at this level reduces the need to aggregate provinces into two regulatory classes. Secondly, the problem of regulatory heterogeneity within a province can be reduced by comparing the performance of similar types of carriers between provinces.

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3. R.K. House and Associates, "Economic Regulation of the For-Hire Trucking Industry" (Report prepared for the Anti-Inflation Board, 1977), p. D.2.

Chapter II

A MODEL OF MOTOR FREIGHT PERFORMANCE

Objectives Guiding Model Development and Methodology

The objective of this analysis is to measure and compare performance of motor carriers under different regulatory environments. To the degree that all of the significant nonregulatory influences on performance can be accounted for, one can attribute residual differences in performance to differences in regulation. In this chapter, a model of carrier performance is developed. The inclusion of the proper independent variables will account for a great proportion of the variance in performance between carriers. In Chapter III, the variance in performance between carriers is further reduced through segmentation of the industry.

Specification of Performance Models: Variables

The general relationship posited in this analysis is described by the function:

$$P = f(O,Q,W,R)$$

where P is a measure of performance, O is output, Q is a vector of summary measures of output quality and traffic characteristics, W is a vector of operating environment characteristics and factor prices, and R represents regulation. For example, we expect a priori that the total costs of a carrier are higher when it produces greater output, produces a higher quality product, produces its product under more severe operating conditions such as bad weather or congested terrain, or has to pay higher prices for fuel and labour.

Performance has many dimensions. The three most obvious are the price charged for a product, the cost incurred in producing the product, and the profit earned from the sale of the product. Excessive rates reflect the combined impact of monopoly pricing and technical inefficiency. Excessive costs reflect the impact of technical inefficiency, and excessive profits or rates of return reflect allocative inefficiency. As noted in Chapter I, the revenue of a carrier can be viewed as the rate paid for a given quantity of trucking service of a given quality. Two carriers producing identical levels of output of similar quality should charge the same rate (generate the same total revenues), incur the same total resource costs of production, and earn the same total net profit. Hence we utilize total operating revenue, total operating cost and total operating profit as the measures of performance in this study. These variables are defined in Table 1.

TABLE 1

Definitions of Dependent Variables

Symbol	Variable	Derivation
TREV	Total operating revenue	Directly from MCF[a]
TCOST	Total operating cost	Directly from MCF
PROF	Operating profit	TREV-TCOST

[a] Motor Carriers-Freight Survey.

Microeconomic theory posits that costs are a function of output (O) and input prices (W). The carrier's level of output can be measured by the total number of shipments. Theoretically, there is no difference between this measure and the other commonly used measure, tonne-kilometres, if the distance and average weight of each shipment are held constant. A comparison of one measure vis-à-vis the other does not suggest any significant advantage in using one or the other (see Appendix A). Number of shipments is the practical choice because it is a priori subject to less measurement error. Motor carriers employ four major types of inputs: labour, capital, fuel and purchased transportation. The price of each of these inputs should theoretically impact on carrier costs and ultimately on prices. Factor prices were available from the 1975 Motor Carriers-Freight Survey (MCF) which provides data to compute the price of labour, fuel and capital by defining the first as total labour cost per employee, the second as fuel expense per litre of fuel and the third as residual expenses per dollar of net fixed assets. Firm-specific prices for purchased transportation could not be computed for Class I carriers because the amount of rented vehicle kilometres was not recorded in the 1975 MCF. Since listwise deletion of missing values is the recommended procedure in multivariate analysis, the unavailability of price of purchased transportation for Class I carriers served to reduce the sample size in several provincial models. The deletion of the larger carriers is undesirable because such a deletion would eliminate carriers in the upper scale range. Preliminary estimations indicate that the impact of deleting the price of purchased transportation is minimal. Consequently, a measure of the price of purchased transportation was left out of the analysis.

The validity of utilizing the price of labour as computed in the performance models could be questioned. As McRae and Prescott note:

> It is often argued that entry regulation cartelizes the industrial structure, thus leading to the existence of monopoly rents as rates are pushed above costs, and new firms are hindered from entering to compete away these rents. Faced with this situation, the International Brotherhood of Teamsters "skim off" some of the rents in the form of wages above what they would have been in a more competitive environment.[1]

However, the same authors find that a comparison of average deflated earnings of trucking employees by province does not fully justify this contention. Their comparison, reproduced in Table 2, indicates that drivers in the nonregulated province of Alberta have the second highest level of deflated earnings. The authors note, however, that "there is some reason to suspect that the drivers in British Columbia have captured some of the rents associated with entry restriction."[2] Consequently, the "skimming" hypothesis is yet to be proven or disproven. The interpretation of the model results will keep this in mind.

There are significant economies in shipment size. As the average shipment size (AWT) increases, a carrier requires less consolidation activity to produce the aggregate transportation service. Thus, we would expect costs to increase less than proportionately with increases in this characteristic of the firm's product. The inclusion of the percentage of LTL shipments (PLTL) is an attempt to model the effect of the dispersion of shipment sizes on performance. We expect that the greater the proportion of LTL, the greater the costs.

---

[1] Effects of Regulation, pp. 19 and 21.

[2] Ibid., p. 21.

TABLE 2

Average Deflated Yearly Earnings by Province, 1975 and 1976

	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Drivers						
1975	1.014	1.084	1.041	1.084	1.164	1.298
1976	1.015	1.135	1.122	1.089	1.162	1.268
Equipment maintenance and garage employees						
1975	0.962	1.033	0.988	0.815	0.980	0.945
1976	0.939	1.052	0.980	0.808	0.926	1.059
Terminal and platform workers						
1975	0.867	0.926	0.893	0.572	0.825	0.997
1976	0.918	0.943	0.957	0.670	0.944	0.991
Sales, tariff and office workers						
1975	0.918	1.030	0.952	0.937	1.030	1.008
1976	0.887	1.035	1.131	0.817	1.027	1.085

Sources: Compiled from Statistics Canada, Motor-Carriers -- Freight and Household Goods Movers, cat. no. 53-222, 1975, 1976 and Employment Earnings and Hours, cat. no. 72-002, 1976. Reproduced from McRae and Prescott, Effects of Regulation.

Similarly, as the average length of haul (AHAUL) increases, the proportion of pickup and delivery and terminal expenses falls so that increases in average length would also result in less than proportionate increases in total costs. We also expect that the larger the percentage of short-haul shipments (SH), the greater the costs. Another quality component is whether the carrier is principally a common carrier or contract carrier, and it can be represented as a 0, 1 dummy or indicator variable (COM), where 1 indicates a common carrier and 0 indicates a contract carrier. This variable may be used in an attempt to measure the effect of common carrier obligations.

The effect of economic regulation on performance is implicit when comparisons of performance between provinces are made. A long tradition has been established in utilizing the performance of intraprovincial trucking as an economic laboratory to help measure the effects of rate and entry control on trucking performance. There are clearly significant differences in the form and severity of economic regulation between provinces although there is some controversy as to how to measure different degrees of regulation.[3] Pending significant evidence to the contrary, the operational state of intraprovincial trucking regulation in the six provinces initially chosen for statistical analysis will follow the McRae-Prescott and House classification scheme for general freight carriers illustrated in Table 3. Such a classification recognizes that economic regulation can be differentiated on at least two bases, entry control and rate control, and that regulation is specific to types of service (i.e., general freight service). Entry regulation is dichotomized into whether it exists or it does not. Rate control is divided into four categories: rate prescription, rate approval, rate filing and none. Four regulatory situations emerge. Manitoba and Saskatchewan are highly regulated with respect to both rates and entry. Quebec and British Columbia restrict entry but only approve rates. Ontario restricts entry but only requires rate filing. Alberta is unregulated in both areas. All provinces employ control through consumer protection provisions.

Each of the independent output, quality, factor price and regulatory variables described above are defined and summarized in Table 4. It should be emphasized that the variables identified in Table 4 exhaust neither all of the possible variables that could be derived from the available data sources nor all of the potentially significant factors that cannot be measured from any public data source at

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[3] See Maister, "Additional Evidence," p. 60.

TABLE 3

Existing State of Intraprovincial Trucking for General Freight Commodities

	Que.	Ont.	Man.	Sask.	Alta.	B.C.
Regulatory body	Quebec Transport Commission	Ontario Highway Transport Board	Highway Transport Board	Highways Traffic Board	Motor Transport Board	Motor Carrier Commission
Entry restriction	Yes	Yes	Yes	Yes	No	Yes
Type of rate legislation	Rate approval	Rate filing	Rate prescription	Rate prescription	None	Rate approval
Consumer protection provision	Yes	Yes	Yes	Yes	Yes	Yes

Sources: House, "Economic Regulation," and McRae and Prescott, Effects of Regulation.

TABLE 4

Definitions of Independent Variables

Symbol	Variable	Estimated by[a]
TSHIP	Total number of shipments	$\frac{\Sigma W}{N}$
AWT	Weighted average weight per shipment	$\frac{\Sigma SW \times W}{\Sigma W}$
AHAUL	Weighted average length of haul	$\frac{\Sigma SW \times D \times W}{\Sigma SW \times W}$
PLTL	Percentage of shipments that are LTL	% of shipments weighing below 4 536 kg on TOD tape
SH	Percentage of shipments that are short-haul	% of shipments moving less than 160.9 km on TOD tape
COM	Common carrier service	Dummy value -- 1 if classified as common carrier, 0 if classifed as contract carrier
WAGE	Average compensation per employee	$\frac{\text{(Employee compensation + U.I.C. pension)}}{\text{Total employees}}$
FUEL	Average cost per litre of fuel	$\frac{\text{(Fuel costs + operating taxes \& licences)}}{\text{(litres diesel + litres gasoline)}}$
CAP	Average cost of capital utilized	$\frac{\text{(Total cost-fuel cost-wage costs-purchased transportation cost)}}{\text{Net fixed assets}}$
REG	Regulation	Dummy value -- 1 if Alberta, otherwise 0. Alberta serves as the base case.

[a] W - individual weighting factor for sampled shipment.
R - revenue of sampled shipment.
SW - weight of individual shipment sampled.
D - distance of sampled shipment.
Σ - summation over complete carrier sample.
N - number of workloads.
TOD - Truck-Origin Destination Survey.

present. Demand factors such as the volume and balance (temporal and geographic) of traffic available to carriers most surely will have an impact on performance as well as the frequency, reliability and availability of service. The potential bias caused by the exclusion of these influences must be kept in mind in the interpretation of the results of the models.

Specification of Performance Models: Functional Form

Previous studies strongly indicate that a nonlinear relationship exists between performance as measured by cost and the independent variables. There is a variety of nonlinear functions ranging from the double-logarithmic specification to the fully saturated translog function. The former is commonly used to represent the neoclassical cost function, but the latter is gaining increasing acceptance because there are few inherent restrictions on the form of the cost function. The translog specification involves the estimation of all second-order and interaction coefficients of all independent variables, in order to provide a local second-order approximation to an arbitrary cost function. Many of the variables are likely to be correlated and the number of parameters to be estimated is quite large, leading to low significance levels. However, microeconomic theory posits that a firm will purchase quantities of input to the point where the marginal product of the input equals its price. Thus cost-share equations can be estimated jointly with the cost equation to add degrees of freedom without reducing the number of parameters to be estimated.

The small number of carriers anticipated to be available in each province limits the full application of the translog function. The neoclassical and the translog functions may take the form of equations 1 and 2 respectively.

$$(1)\quad \ln C = a_o + \Sigma a_i \ln W_i + \Sigma b_j \ln Q_j + C_o \ln O$$

$$(2)\quad \ln C = a_o + \Sigma a_i \ln W_i + \Sigma b_j \ln Q_j + C_o \ln O$$
$$+ \Sigma\Sigma A_{il} \ln W_i \ln W_l + \Sigma\Sigma B_{jm} \ln Q_j \ln Q_m$$
$$+ C_{oo} (\ln O)^2 + \Sigma\Sigma d_{ij} \ln W_l \ln Q_j + \Sigma\Sigma E_{oi} \ln O \ln W_i$$
$$+ \Sigma\Sigma E_{oj} \ln O \ln Q_j$$

Where: C = total cost
O = output
W_i = vector of factor prices
Q_j = output quality vector.

Assume that there are three factor prices and three quality variables. In such a case, 24 parameters need to be estimated in the translog model. The degrees of freedom (given the sample size) would be quite small unless they are increased by estimating factor share equations simultaneously with equation 2. Where the number of exogenous independent variables is large, the translog function is less reliable. Given the number of anticipated sample carriers per province, it is probable that many a priori restrictions would have to be imposed on equation 2. Considering that neither a rigorous nor an intuitive rationale exists to justify the application of the translog specification to revenue functions, the specification utilized in the analysis of intraprovincial carriers will be unrestricted with respect to the output variable (i.e., c_{oo} is not assumed to equal 0), but fully restricted with respect to all other second-order terms.

Thus, the basic specification utilized in this research is:

$$(3) \quad \ln P = a_o + \Sigma a_i \ln W_i + \Sigma b_j \ln Q_j + C_o \ln O + C_{oo} (\ln O)^2$$

Where P is the dependent variable, performance.

Chapter III

INDUSTRY SEGMENTATION AND EVALUATION OF DATA SOURCES

An Overview of the Trucking Industry

The objective of this analysis is to measure and compare revenues, costs and profits of carriers operating under different regulatory environments. This objective is made difficult to achieve by the existence of considerable diversity in the products produced and, consequently, the technology employed by firms in the trucking industry. It is preferable to remove some of this heterogeneity in the process of modeling trucking performance by segmenting carriers into homogeneous groups for study. This segmentation should be made on the basis of economic distinctions rather than legal definitions of market segments unless there is a reasonable correspondence between legal and economic boundaries.

The potential economic and the actual legal definitions of the trucking market segments are many. One economic classification is based on the shipment size for which the carrier normally provides movement services. The less-than-truckload (LTL) carrier is readily distinguished from the truckload (TL) carrier through its use of terminal facilities as an interface between its local pickup and delivery (P&D) operations and its intercity linehaul operations. Such carriers perform a shipment consolidation function as well as a movement function. In contrast, the TL carrier requires no such interface (terminal operations) as it normally picks up and delivers directly from door to door. For a TL shipment, the carrier only provides movement services and the shipper performs the consolidation or deconsolidation (i.e., the shipper accumulates sufficiently large vehicle loads). Note that the LTL carrier is not limited to the movement of LTL shipments as it can and does compete for TL freight. However, the TL carrier cannot efficiently consolidate small shipments as a major portion of its business without terminal facilities.

The trucking industry is not presently segmented into LTL and TL classifications for statistical purposes. However, carriers are frequently identified by the major type of commodity that is transported. The Motor Carriers-Freight Survey (MCF) identifies 18 product categories (17 specific product categories and 1 miscellaneous category for all commodities not specifically named). The number (N) of carriers earning the majority of their revenues from each of

TABLE 5

Carriers Classified by Major Source of Revenue and Serving Six Study Provinces

Commodity Group (1)	Population		Study Sample	
	N (2)	% (3)	N (4)	% (5)
Auto carriers	12	.5	10	1.7
Household goods	160	6.3	-	-
Heavy machinery mover	29	1.1	12	2.1
Petroleum products	184	7.2	43	7.4
Refrigerated liquid products	6	.2	1	.2
Refrigerated solid products	16	.6	14	2.4
Dump trucking	332	13.0	21	3.6
Agricultural commodities	13	.5	5	.9
Live animals	8	.3	4	.7
General freight	957	37.5	291	50.2
Armoured truck service	-	-	-	-
Building materials	29	1.1	11	1.9
Dry bulk in tanks	22	.9	12	2.1
Forest products	251	9.8	37	6.4
Mine ores	5	.2	3	.5
Retail store delivery	2	.1	1	.2
Explosives	1	.0	1	.2
Commodities not specified above or no dominant commodity	527	20.6	114	19.7
Total	2 554	100.0	580	100.0

Source: Compiled from MCF tape.

Note: A commodity group is considered a major source if greater than 50 per cent of the 1975 annual operating revenue was earned from the movement of that commodity.

the product categories is shown in Column 2 of Table 5.[1] It is unlikely that a homogeneous technology exists across all of these carrier groups. Household goods utilize high cube vans due to the low-density nature of household goods. Auto carriers utilize special rack trailers or specially designed truckaway units. In general, most carriers of other than general freight (i.e., nongeneral freight or NGF) are TL carriers, but the type of equipment and prevailing operating techniques are commodity specific. (There may be, however, enough similarities between some groups to warrant combining them as one.) Consequently, it is more likely that a meaningful estimation of a performance model would require analysis within a commodity group.

In particular, the majority of the carriers of general freight (GF) are LTL carriers which utilize labour-intensive terminals. Boucher observes that "as a rule, a general carrier uses class rates and special rates (commodity rates) because it transports less-than-truckload lots as well as truckload lots. A specialty carrier uses special rates (commodity rates) in particular because it transports products in truckload lots."[2] This commodity-defined segment of the industry is by far the most important in terms of number of participants and total revenue.

Another legal distinction that has economic validity is the provision of common carrier service as opposed to contract carrier service. Contract carrier service is normally a specific service to a limited number of customers with similar needs. Contract carrier operations frequently involve TL movements. Common carrier service implies that the carrier holds itself out to the general public to engage in the transportation of specified commodities between specified points.[3] This "common carrier obligation" is purported to result in higher service under uncertain and varying conditions of temporal and geographic demand. The number of common and contract carriers are shown in Column 2 of Table 6.

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[1] Only carriers serving the six provinces identified in Table 3 are counted.

[2] Analysis of Regulations, p. 21.

[3] In Alberta where entry control does not exist, whether the carrier provides common or contract service is determined by the carrier.

TABLE 6

Carriers by Type of Service Serving Six Study Provinces

	Population		Study Sample	
(1)	N (2)	% (3)	N (4)	% (5)
Common	1 567	61.4	431	74.3
Contract	987	38.6	149	25.7
Total	2 554	100.0	580	100.0

Source: Compiled from MCF tape.

Motor carriers may also be classified by normal operating distances for its movements. Statistics Canada normally distinguishes local carriers (i.e., carriers transporting the bulk of their freight less than 15 miles) from intercity carriers. This boundary may have regulatory significance because some regulating provinces exempt intraurban cartage from economic regulations. For example, Ontario requires an operating licence "except where such operation takes place within an urban zone" while in Quebec, "the intent is that intra-urban cartage is in the regulatory sphere of the Commission."[4] Less formal recognition is given to the differences between long- and short-haul carriers. Short-haul carriers tend to engage in peddle operations, use truck equipment (as opposed to tractor-trailer units) and return their drivers to their home terminal areas daily. Long-haul carriers are more likely to employ a complex terminal system utilizing a mix of origin-destination terminals, relay stations and break-bulk operations to maximize efficiency.[5]

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4. House, "Economic Regulation," pp. 91, 106 fn.

5. Classification of the trucking industry into economic subindustries is further discussed in G. Chow, The Economics of the Motor Freight Industries (Bloomington, Ind.: Division of Research, School of Business, Indiana University, 1978a), chap. 4.

The goals of this study require the trucking industry to be segmented into extraprovincial and intraprovincial categories and by type of economic regulation. If economic controls were uniform throughout the industry, the distinctions would not be relevant (nor this comparative analysis possible). The number of motor carriers in these groups are shown in Column 2 of Table 7.

TABLE 7

Carriers by Areas Served

	Population		Study Sample	
(1)	N (2)	% (3)	N (4)	% (5)
Quebec	506	19.8	93	16.0
Ontario	548	21.5	96	16.6
Manitoba	64	2.5	13	2.2
Saskatchewan	38	1.5	13	2.2
Alberta	213	8.3	54	9.3
British Columbia	327	12.8	38	6.6
Total intraprovincial	I 696	66.4	307	52.9
Interprovincial carriers or international	858	33.6	273	47.1
Grand total	2 554	100.0	580	100.0

Source: Compiled from MCF tape.

Note: Intraprovincial carriers were identified as carriers doing 100 per cent of their business in a single province.

In summary, the Canadian trucking industry cannot be considered a single homogeneous entity. Grouping carriers which have tendencies to utilize different equipment and operating technologies serves only to disguise cost or revenue relationships through the averaging process. Grouping of carriers may also disguise the impact of economic regulation since some carriers may be more regulated than others in the same province. Furthermore, the goals of the research require that intraprovincial carriers be separated from extraprovincial carriers and that the former be further classified by province.

Evaluation of Available Data Sources and Initial Segmentation of the Canadian Trucking Industry

Two major sources of data on Canadian Trucking were available for this study. The For-Hire Trucking Origin and Destination Survey (TOD) collects data on individual shipments including origins and destinations of shipments, commodities carried, weights of goods and revenue received from their transport. The Motor Carriers-Freight Survey (MCF) is a compilation of firm-level statistics including balance sheet, income statement and operating statistics. Both surveys are conducted annually by Statistics Canada. Data collected for 1975 was made available on magnetic tape and did not identify any carrier by name or publicly decipherable codes.[6]

The analysis of trucking performance requires that elements of both surveys be utilized. The MCF data contained information on firm revenues, costs, profits and other operating measures. However, the MCF data did not include any information on the level and quality of output. Estimates of the number of shipments, average weight per shipment, length of haul and other quality measures can be made from the TOD data.[7] As a consequence, the availability of data from the TOD survey served to limit the number of carriers that could be studied. As displayed in Table 8, 580 carriers serving the six provinces of interest in this study were matched with their respective statistics from the TOD survey. Table 8 also indicates that the larger carriers are heavily represented.

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[6] The surveys are summarized and explained in Statistics Canada, Motor Carriers -- Freight and Household Goods Movers -- 1975, cat. no. 53-222 (Ottawa, 1978), pp. 9-20 and id., For-Hire Trucking Survey -- 1975, cat. no. 53-224 (Ottawa, 1977), pp. 5-15. Details of the survey design for the TOD survey are contained in Statistics Canada, The For-Hire Trucking Origin and Destination Survey: Survey Design (Ottawa, 1975), pp. 5-14.

[7] Though some of this information *is* collected in the actual MCF survey, it is not recorded. Statistics Canada personnel indicate that the estimates made by the carriers are largely inaccurate.

TABLE 8

Classification of Carriers by Availability of Data

Group	Class I	Class II	Class III	Total
Carriers in MCF survey	183	537	2 036	2 756
Carriers serving six study provinces				2 554
Carriers in MCF survey with matching data from TOD study	167	214	258	639
Carriers serving six study provinces	163	184	233	580
Carriers with no missing information				544

The TOD survey was intended to provide information on the domestic intercity movements of goods by the trucking industry by sampling shipments in a two-stage stratified sampling process. The first stage picked data location points which are synonymous with carriers; that is, a sample of carriers was chosen. The second stage selected a sample of shipments from each carrier. From the point of view of the first stage sampling design, the characteristics of the selected carriers can be viewed as representative of the industry as a whole. However, from the point of view of the overall sampling design, the TOD data was never intended to be used in the estimate of firm characteristics. As a consequence, one would expect that the measure of relative dispersion for the estimates of a particular firm characteristic (i.e., the coefficient of variation) would be large and the conclusions made from such data unreliable. Methodologically this need not be a serious constraint because the reliability of the data would be reflected in the lack of explanatory power in the proposed regression analysis.

A more serious concern is whether there exists any systematic bias in the data with respect to differences in the regulatory environment. For example, assume that the level and quality of output is overstated (understated) for carriers in Ontario relative to the level and quality of output in Alberta. This would lead to an overstatement (understatement) of the relative efficiency of Ontario carriers vis-à-vis Alberta carriers, ceteris paribus. It is reasonable to expect that the record keeping procedures of carriers and the data collection procedures employed by Statistics Canada are uniform between provinces for equal size carriers. However, the TOD survey deletes local shipments, certain types of purchased transportation and other special shipments from its workload sample. This leads inevitably to an underestimate of the total carrier operating activity which is associated with the cost and revenue of the firm. Operating revenues can be estimated from both the MCF and TOD surveys and a comparison of the two estimates by province will allow any bias in the data to be identified and corrected for later in this report.

The segmentation of the Canadian trucking industry into more homogeneous classes involves a certain amount of judgement and is conditioned by several factors. First, data on the economic characteristics of carriers may not be available to classify carriers. Fortunately, the TOD and MCF surveys do contain measures of the major economic characteristics discussed in the first section of this chapter. Second, the greater the number of homogeneous groups that are defined, the fewer the observations that will be available for model calibration. This problem becomes particularly acute when the analysis of performance is centred on any particular province. For example, Ontario has the largest number of intraprovincial carriers with complete data. These carriers could be segmented as shown in Table 9. Although two groups have populations exceeding 20, this would hardly be the case in Alberta, Manitoba-Saskatchewan and British Columbia where only 54, 26 and 38 total observations respectively are available. It is obvious that the segmentation process can only go so far before every trucking subindustry is represented by a very small number of carriers.

A third factor is the selection of the boundaries between each type of carrier. At what average shipment weight does a carrier generally take on the economic structure of a less-than-truckload carrier vis-à-vis a truckload carrier? Indeed, are the cost structures between GF and NGF carriers, between LTL and TL carriers and between long- and short-haul carriers different? This issue is further complicated by the fact that nearly all carriers provide a mix of these services.

The objective of this research is to ascertain the impact of economic regulation. The minimum grouping of carriers shall be: (1) whether the carrier is intrapro-

TABLE 9

Arbitrary Segmentation of Intraprovincial Ontario Carriers with Data in the TOD and MCF Surveys

Segmentation Criteria / Group	Commodity		Shipment Size		Operating Distance		Number of Carriers
	General Freight	Nongeneral Freight	Less-than-Truckload	Truckload	Short-Haul	Long-Haul	
1	X		X		X		27
2	X		X			X	4
3	X			X	X		19
4	X			X		X	2
5		X	X		X		10
6		X	X			X	1
7		X		X	X		29
8		X		X		X	2
						Total	94

Note:

General freight (GF) - GF traffic $>$ 50 per cent.

Nongeneral freight (NGF) - GF traffic $\leq$ 50 per cent.

Less-than-truckload (LTL) - average shipment weight $<$ 4 536 kg.

Truckload (TL) - average shipment weight $\geq$ 4 536 kg.

Short-haul (SH) - average length of haul $<$ 322 km.

Long-haul (LH) - average length of haul $\geq$ 322 km.

X indicates characteristic of group.

vincial or extraprovincial, (2) province of operations and, therefore, regulatory jurisdiction and (3) type of commodity. This first grouping is necessary because only intraprovincial carriers can truly be said to be influenced by a particular regulatory environment. Actually all extraprovincial carriers are regulated to some degree. No benchmark or control situation is available to compare extraprovincial performance as is the case for intraprovincial performance where the performance of Alberta carriers can be used as the unregulated case. Furthermore, it would be difficult and highly judgemental to separate regulatory influences on carriers which conduct both intra- and extraprovincial business.

The requirement for the second grouping criteria is obvious. The differences in intraprovincial regulation provide the basis for using provincial differences in regulation to create an economic laboratory. Regulations are not identical between any two provinces so that pairwise comparisons of performance between provinces should shed light on the effects of regulation.

The third grouping requirement recognizes that the degree and severity of economic regulation can vary with the type of carrier as classified by the class of commodity transported. The movement of some commodities is exempt from economic regulation in some provinces but regulated in others. Several provinces have established a series of operating authority classes for which regulation is more or less severe. It would be an overstatement, therefore, to claim regulation is homogeneous in any single province.

R.K. House conducted the most comprehensive ranking of provincial regulatory environments to date.[8] One conclusion of the House report was summarized in Table 3 and pertains only to general freight carriers. As House notes, "It must be remembered that if another segment of the industry (that is, non-general freight) were to be examined, it is almost certain the entire chart would change."[9] This analysis recognizes House's perception of regulation and concentrates on general freight carriers. Several economic considerations solidify this decision. It is unlikely that carriers of general freight exhibit the same cost and revenue behaviour as carriers specializing in specific or other than general freight (NGF) commodities. Maister notes

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[8] See House, "Economic Regulation."

[9] Ibid., p. 150.

that the failure to take into account demand conditions has been a weakness in this research tradition.[10] The value of service differences that exist between provinces can be minimized (though obviously not eliminated) by concentrating on general freight carriers. General freight, as noted earlier, normally moves on class rates which are based on value of service and cost of service considerations. Specialty carriers normally apply commodity rates which are heavily based on cost of service. The value of service is probably higher for general freight service since such carriers tend to transport finished goods of high per unit value. Other carrier types are engaged in transporting raw, unprocessed or semifinished products whose low value encourages cost-based pricing. Finally, the level and type of competition will vary between types of carriers. A railway does not compete with a general freight carrier for LTL traffic in the same way as it does against a carrier specialized in transporting TL lots. The fact that supply and demand heterogeneity exists between GF carriers and NGF carriers provides an economic as well as an institutional rationale for segmentation.

The requirement that carriers must be 100 per cent intraprovincial carriers in order that regulatory impact can be clearly associated, reduces the number of carriers available for study to 351. Of these, 182 were general freight carriers but only 158 operated in the six provinces identified in Table 3. They are distributed as shown in Table 10.

TABLE 10

Maximum Number of Carriers Available for Performance Comparisons -- General Freight, Intraprovincial

Quebec	51
Ontario	52
Manitoba-Saskatchewan	14
Alberta	28
British Columbia	13

Source: Compiled from MCF tape.

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[10] "Additional Evidence," p. 60.

It is readily apparent that even without further subgrouping, the sample sizes available for Manitoba-Saskatchewan and British Columbia are quite small. It is therefore decided to eliminate these provinces from further analysis. Reference to Table 3 indicates that this deletion will eliminate any implications about the efficiency of strict entry with strict rate regulation.

The next task is to determine whether further segmentation is necessary or desirable. Several potential grouping variables were recognized previously. The distinction between LTL and TL carriers and between common and contract carriers is examined here. The distinction between long- and short-haul carriers is not examined because the initial selection of intraprovincial carriers eliminates, for the most part, the long-haul carriers from the study.[11] We approach the problem by assuming that sample data is collected for two different industries to calibrate long run cost curves. We wish to test whether the two resulting regression lines are the same and thus determine whether the two samples can be pooled. A general linear test of the equality of two regression lines is described in Appendix B and utilized here.

In order to identify relevant industry segments, full (F) and reduced (R) cost models were calibrated on the 182 intraprovincial carriers using various criteria. The full model estimates two separate regression lines (i.e., one for TL carriers, one for LTL carriers) while the reduced model estimates a single regression line for both groups combined. The cost model is specified as follows (equation 4):[12]

$$(4)\ \mathrm{TCOST} = a_o + a_1\,\mathrm{WAGE} + a_2\,\mathrm{FUEL} + a_3\mathrm{CAP} + b_1\,\mathrm{AWT} + b_2\,\mathrm{AHAUL} + b_3\,\mathrm{PLTL} + C_o0 + C_{oo}0^2$$

All variables were transformed into their natural logarithms.

These models are estimated for the entire intraprovincial set of carriers rather than by province in order to be able to screen out some of the explanatory variables and to allow testing of the significance of further segmentation. It is very unlikely that variables found to be insignificant at this stage would be significant in the smaller

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[11] The range of the average length of haul for the sample carriers shown in Table 23 confirms this.

[12] Refer to Table 4 for definition of variables.

provincial samples. The results are displayed in Tables 11 and 12. In Table 11, the industry is segmented into several TL and LTL segments. In Table 12, the industry is segmented according to the type of service, common or contract.

Examination of the F statistic (described in Appendix B) in each of these tables indicates that only SSE(F), the error sum of the squares of the full model, varies between the estimations, and the smaller the value of SSE(F), the larger the F statistic. Consequently, the set of segmented regressions resulting in the smallest SSE(F) identified the industry segmentation that is most likely to represent "different" homogeneous groups of carriers possessing different cost behaviour. As shown in Table 11, the segmentation of carriers into LTL and TL classes results in the lowest SSE(F) where a cut-off of 4 536 kg is used, although the difference between that cut-off and the higher cut-off of 6 804 kg is very small. The SSE(F) is similarly reduced when the industry is segmented by common versus contract carriers.

These results strongly suggest that the cost structure of LTL carriers does indeed differ from the cost structure of TL carriers and likewise between common and contract carriers. It would be exceedingly difficult, however, to segment by both criteria as indicated earlier. One possible solution is to use a dummy variable to represent TL carriers or common carriers. This would be appropriate if the effect of switching from a LTL to a TL business or from a contract to a common carrier business falls primarily on the cost intercept rather than on the slopes of the regression model. Equation 5 was estimated separately with a TL indicator variable and with a common carrier indicator variable. The resulting indicator variables were insignificant, suggesting that the difference between LTL and TL carriers and common and contract carriers is embodied in the slopes of the regression coefficients. This is easily verified by calculating the optimal scale (OS) for LTL and TL carriers. Using the coefficients from the LTL and TL models that assumed that an AWT of 6 804 kg was the boundary:

(i) $OS_{LTL} = \exp \frac{(1--1.6106)}{2(.1156)} = 80\ 139$ shipments

(ii) $OS_{TL} = \exp \frac{(1--1.0319)}{2(.0979)} = 32\ 126$ shipments

(iii) $OS_{ALL} = \exp \frac{(1--.8498)}{2(.078)} = 127\ 036$ shipments.

The calculations demonstrate that significantly different economies of scale are estimated for the separate

TABLE 11

Coefficient Estimates of Cost Model on LTL-TL Industry Segments

Variable	Total	LTL (AWT $\leq$ 4 536 kg)	TL (AWT $>$ 4 536 kg)	LTL (AWT $\leq$ 6 804 kg)	TL (AWT $>$ 6 804 kg)	LTL (AWT $\leq$ 9 072 kg)	TL (AWT $>$ 9 072 kg)
TSHIP	-0.8498*	-1.7631*	-1.0118*	-1.6106*	-1.0319*	-1.3963*	-1.1025*
$TSHIP^2$	.0787*	0.1235*	0.0996*	0.1156*	0.0979*	0.1053*	0.0978*
AHAUL	.0622	0.1697*	0.0716	0.1721*	-0.0550	0.1429**	-0.1165
AWT	.4206*	0.2669*	0.4564	0.3563*	0.4802	0.3633*	0.1311
PLTL	.1935*	-1.3592	0.1683**	0.0005	0.1958*	0.1477	0.2518*
WAGE	.8190*	0.9473*	0.2484	1.0406*	-0.0416	0.9962*	-0.2916
FUEL	- .1364	0.0508	-0.1641	-0.0703	-0.2581	-0.0958	-0.2248
CAP	0.0399	-0.0421	0.2190	-0.0323	0.2659	-0.0302	0.2509
N	182	130	52	139	43	149	33
R^2	74.02	78.48	70.64	77.46	70.06	76.69	72.30
R^2 adjusted	72.82	77.05	65.17	76.07	63.02	75.36	63.06
SSE	77.8443	47.1140	22.9083	53.6483	16.9837	57.7949	13.1180
df	173	121	43	130	34	140	24

* Significant at the .05 level.

** Significant at the .10 level.

TABLE 12

Coefficient Estimates of Cost Model on Common and Contract Carriers

Variable	Total	Common	Contract
TSHIP	-0.8498*	-0.9520*	-0.6232**
$TSHIP^2$	.0787*	.0860*	.0580*
AHAUL	.0622	.1185	.0503
AWT	.4206*	.4992*	.2676*
LTL	.1935*	.2457*	.1290
WAGE	.8190*	.9496*	.2044
FUEL	- .1364	- .0706	- .3907**
CAP	-0.0399	-0.0131	-0.1783
N	182	149	33
R^2	74.02	77.20	69.30
R^2 adjusted	72.82	75.90	50.07
SSE	77.8443	58.4024	9.5872
df	173	140	24

* Significant at the .05 level.
** Significant at the .10 level.

segments and that the impact of combining the two heterogeneous groups is to overestimate economies of scale. While the latter result may be peculiar to this set of data, it does highlight the hazards of ignoring the differences between LTL and TL carriers.

Tables 11 and 12 also indicate that a few independent variables are consistently significant and several are consistently insignificant. Specifically, the price of fuel and the price of capital are not significant in any calibration. This is not unexpected inasmuch as each of these inputs comprises approximately 10 per cent of total costs. Consequently, variations in these prices have a marginal effect on total cost relative to wages which account for over 40 per cent of total costs. Average haul is insignificant in several estimates, which may reflect the intraprovincial limitation on the variability of this characteristic or the inclusion of carriers with significant local cartage business. The percentage of LTL shipments is insignificant in the LTL groups as would be expected since this measure would approach a limit of 100 per cent for all LTL carriers.[13]

Three separate equations for each performance dimension are initially estimated since we are unable to utilize indicator variables to account for heterogeneity between LTL and TL and between common and contract carriers estimated when using all carriers in a province. The following equation is estimated using all carriers in a province (combined group):

$$(5)\ TCOST = a_o + a_1\ WAGE + b_1\ AWT + b_2\ AHAUL + b_3\ PLTL + C_o O + C_{oo} O^2$$

The following equation is estimated when using LTL carriers, where a LTL carrier is defined as a carrier with an average weight per shipment of 6 804 kg or less:

$$(6)\ TCOST = a_o + a_1\ WAGE + b_1\ AWT + b_2\ AHAUL + C_o O + C_{oo} O^2$$

The following equation is estimated when using common carriers:

$$(7)\ TCOST = a_o + a_1\ WAGE + b_1\ AWT + b_3\ PLTL + C_o O + C_{oo} O^2$$

---

[13] The variable SH was found to be completely insignificant in preliminary model estimations reported in Appendix A. Since SH was highly correlated with AHAUL, it was deleted from further testing.

The estimation of performance models for TL and contract carriers is constrained by the sample sizes in each province as shown in Table 13. It is reasonable to conclude that the conclusions made about comparative common carrier and LTL performance would also apply to contract carrier and TL carrier performance if equation 5 comparisons are consistent with equation 6 and 7 comparisons. Note that TREV or TPROF may be substituted for TCOST in equations 5 to 7 if performance is to be measured by rates or profits.

Summary

We may summarize the methodology at this point. Revenue, cost and profit functions will be initially estimated with identical specifications for comparative purposes as it is likely that all three measures of performance depend on the common explanatory variables. The basic questions posed are:

(1) Do carriers in province X receive more, the same or less revenue than carriers in province Y for an equal quantity and quality of product under similar operating conditions (i.e., input price levels)?

(2) Do carriers in province X incur greater, the same or lower costs than carriers in province Y in producing an equal quantity and quality of product under similar operating conditions?

(3) Do carriers in province X earn higher, equal or lower profits than carriers in province Y in the production of comparable products under similar operating conditions?

Light is shed on these issues by estimating performance in each province as a function of common explanatory variables with common values. The differences in provincial performance that remain unexplained by the nonregulatory variables in the models can be attributed to other exogenous differences between the provinces, one of these differences being the regulatory environment. Homogeneity of the carriers according to regulation is maintained by concentrating on general freight, intraprovincial carriers. Homogeneity of the carriers according to economic characteristics is improved by estimating performance for LTL and common carriers alone. The lack of a significant number of observations for Manitoba-Saskatchewan and British Columbia led to their exclusion from the present analysis.

TABLE 13

Intraprovincial, General Freight
Carriers Serving the Six Study
Provinces by Province and Type of Service

	LTL		TL		Total Province
	Common	Contract	Common	Contract	
Alberta	18	0	5	5	28
Manitoba-Saskatchewan	11	1	2	0	14
Ontario	24	6	16	6	52
British Columbia	10	1	1	1	13
Quebec	39	3	5	4	51
Total	102	11	29	16	158

Source: Compiled from MCF tape.

Chapter IV

AN ANALYSIS OF INTRAPROVINCIAL TRUCKING PERFORMANCE

Analysis of Model Validity

Equations 5, 6 and 7 were estimated as total revenue, total cost and total profit functions of intraprovincial general freight carriers for each province. Manitoba-Saskatchewan and British Columbia carriers were deleted due to the smallness of their sample size. Tables 14 to 16 represent the results of the revenue models, and Tables 17 to 19 display the cost model results. The results of the profit function estimation were generally insignificant as demonstrated in Table 20, which shows the results of estimating total profits for all carriers in each province (equation 5). The F values for both Ontario and Alberta do not exceed their respective critical F values at five per cent; thus we cannot reject the null hypothesis that the population regression coefficients equal zero in the profit model. Unfortunately, the weak profit relationship estimated for Alberta carriers removes the benchmark with which we can compare regulated profit levels. The direct analysis of profits is thus deleted in the remaining analysis.

The coefficients of the cost model are now examined for consistency with a priori expectations. Each of the coefficients in each model measures the elasticity of total cost with respect to the corresponding variable. The shipment size coefficients (AWT) are all significant and are of the expected sign.[1] Costs also increase as a greater percentage of shipments are LTL in Ontario and Alberta. The length of haul coefficients are also of the correct sign but significant only in the LTL segment of Quebec and Alberta trucking (see Table 18). The lack of significance of these coefficients for the combined carrier groups in each province again demonstrates how the merging of both TL and LTL carriers can distort the observed relationship. Finally, the price of labour appears to have a significant impact on total costs only in Quebec.

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[1] In this investigation, signs are assumed neutral if the coefficient is not significantly different from zero.

TABLE 14

Coefficient Estimates for Revenue Model of Intraprovincial, General Freight Carriers

Coefficient	Variable[a]	Quebec	Ontario	Alberta
a_o	Constant	1.9673	-0.8230	4.6143
c_o	0	-2.0881	- .2860	-2.0716
		(0.5644)[b]	(.5767)	(0.4156)
c_{oo}	0^2	0.1461	.0446	0.1440
		(0.0302)	(.0308)	(0.0237)
b_1	AWT	0.2761	.3495	0.4362
		(0.0957)	(.0915)	(0.0605)
b_2	AHAUL	0.0631	- .0158	0.2478
		(0.1109)	(.1769)	(0.1104)
b_3	PLTL	0.03394	.2190	0.2945
		(0.0907)	(.1000)	(0.0729)
a_1	WAGE	0.9123	.2961	0.2476
		(0.3070)	(0.4127)	(0.2860)
R^2		82.96	70.04	88.37
R^2 adjusted		80.64	66.04	85.05
N		51	52	28

[a] ln omitted.

[b] Standard errors in parentheses.

TABLE 15

Coefficient Estimates for Revenue Model of Intraprovincial, General Freight, LTL Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	2.0165	-0.4363	39.0302
c_o	0	-2.0409	- .5031	-8.3151
		(0.5787)[a]	(.6070)	(2.5694)
c_{oo}	0^2	0.1414	.0528	0.4619
		(0.0308)	(.0325)	(0.1322)
b_1	AWT	0.3008	.3005	0.2875
		(0.0949)	(.1074)	(0.1573)
b_2	AHAUL	0.2772	.0711	0.4886
		(0.1388)	(.1996)	(0.1469)
a_1	WAGE	0.7869	.4982	-0.0496
		(0.3224)	(0.6447)	(0.3198)
R^2		84.26	76.85	91.79
R^2 adjusted		82.34	72.72	88.37
N		47	34	18

[a] Standard errors in parentheses.

TABLE 16

Coefficient Estimates for Revenue Model of Intraprovincial, General Freight, Common Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	-0.1707	-3.5503	5.5477
c_o	0	-2.0558	0.2193	-2.5407
		(0.6094)[a]	(0.6173)	(1.2440)
c_{oo}	0^2	0.1444	0.0246	0.1668
		(0.0321)	(0.0321)	(0.0634)
b_1	AWT	0.3288	0.3763	0.5219
		(0.1189)	(0.0862)	(0.0967)
b_3	PLTL	0.03276	0.1681	0.4870
		(0.3288)	(0.1083)	(0.2676)
a_1	WAGE	1.1197	0.2620	0.3812
		(0.3417)	(0.4327)	(0.3320)
R^2		83.61	72.31	85.72
R^2 adjusted		81.45	68.24	81.52
N		44	40	23

[a] Standard errors in parentheses.

TABLE 17

Coefficient Estimates for Cost Model of Intraprovincial, General Freight Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	2.6279	-1.2356	4.6847
c_o	0	-2.0935	-0.3406	-1.9646
		(0.5842)[a]	(0.5757)	(0.5534)
c_{oo}	0^2	0.1476	0.0471	0.1399
		(0.0313)	(0.0307)	(0.0315)
b_1	AWT	0.2729	0.3505	0.4897
		(0.0991)	(0.0913)	(0.0806)
b_2	AHAUL	0.0725	0.0159	0.1537
		(0.1148)	(0.1766)	(0.1470)
b_3	PLTL	0.0115	0.2250	0.2920
		(0.0939)	(0.0998)	(0.0971)
a_1	WAGE	0.8346	0.3476	0.1719
		(0.3178)	(0.4120)	(0.3808)
R^2		82.53	70.67	81.11
R^2 adjusted		80.15	66.76	75.71
N		51	52	28

[a] Standard errors in parentheses.

TABLE 18

Coefficient Estimates for Cost Model of Intraprovincial, General Freight, LTL Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	2.4831	-0.6650	40.0620
c_o	0	-2.0270	- .5605	-8.5855
		(0.6018)[a]	(.6164)	(3.7053)
c_{oo}	0^2	0.1420	.0557	0.4761
		(0.0320)	(.0329)	(0.1906)
b_1	AWT	0.2936	.3029	0.3673
		(0.0987)	(.1081)	(0.2269)
b_2	AHAUL	0.2756	.0971	0.3991
		(0.1443)	(.2027)	(0.2119)
a_1	WAGE	0.7174	.5339	-0.0437
		(0.3352)	(0.6548)	(0.4612)
R^2		83.85	76.90	84.99
R^2 adjusted		81.89	72.78	78.73
N		47	34	18

[a] Standard errors in parentheses.

TABLE 19

Coefficient Estimates for Cost Model of Intraprovincial, General Freight, Common Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	0.5261	-4.1421	9.1001
c_o	0	-2.0422	0.1595	-3.4658
		(0.6274)[a]	(0.6162)	(1.4407)
c_{oo}	0^2	0.1451	0.0281	0.2136
		(0.0330)	(0.0320)	(0.0734)
b_1	AWT	0.3205	0.3937	0.6177
		(0.1224)	(0.0861)	(0.1121)
b_3	PLTL	-0.0303	0.1774	0.7272
		(0.3385)	(0.1081)	(0.3099)
a_1	WAGE	1.0562	0.3260	0.2901
		(0.3519)	(0.4320)	(0.3845)
R^2		83.43	73.15	83.44
R^2 adjusted		81.25	69.20	78.57
N		44	40	23

[a] Standard errors in parentheses.

TABLE 20

Coefficient Estimates for Profit Model of Intraprovincial, General Freight Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	-26.3409	16.2677	-12.9441
c_o	0	-1.4122	0.1106	-2.3435
		(2.0433)[a]	(1.6318)	(2.7346)
c_{oo}	0^2	0.0931	0.0334	0.1617
		(0.1095)	(0.0871)	(0.1559)
b_1	AWT	0.4215	0.2832	0.0018
		(0.3466)	(0.2589)	(0.3983)
b_2	AHAUL	-0.6107	-1.3244	0.7239
		(0.4016)	(0.5007)	(0.7262)
b_3	PLTL	0.5676	-0.1882	-0.0896
		(0.3285)	(0.2829)	(0.4798)
a_1	WAGE	3.3931	-1.4105	2.1240
		(1.1115)	(1.1680)	(1.8818)
R^2		31.57	23.66	24.21
R^2 adjusted		22.24	13.49	2.56
N		51	52	28
F*		3.38	2.32	1.12
F(.05,6,n=7)		2.31	2.31	2.57

[a] Standard errors in parentheses.

Scale economies (ε) for the function used in this analysis can be defined as:

$$\varepsilon = \frac{c}{\ln O} \quad C_O + 2\, c_{OO} \ln O$$

At the point at which scale economies are exhausted, optimum scale (OS) is derived by finding the output level (O) where:

$$c_O + 2\, c_{OO} \ln O = 1;\ \text{or}$$

$$O = \exp \frac{(1 - C_O)}{(2\, c_{OO})}$$

TABLE 21

Optimal Firm Size (Shipments)

Carrier Segment	Quebec	Ontario	Alberta
Combined	35 573	1 515 751	39 952
LTL	42 551	1 212 359	23 545
Common carrier	35 707	3 126 785	34 671

The optimum scale for each province by cost model is computed and shown in Table 21. In Table 22, the distribution of all carriers by output level is shown and in Table 23 selected characteristics of the combined carrier groups in each province are displayed. Based on Tables 21 and 22, it would appear that the majority of the Quebec carriers are facing a declining long run cost curve, but 20 per cent exceed optimal scale. No Ontario carrier exceeds the optimal scale measured for these carriers. The Alberta distribution of carriers, relative to optimum scale, is similar to that of Quebec. We are reluctant to attach too much importance to specific numerical estimates in this report. The consistently large estimates of optimal scale in Ontario do suggest that all Ontario carriers face a declining long run cost curve, but this is based on coefficients for output which have high standard errors. One possible hypothesis explaining the larger optimum scale for Ontario carriers is that the effective imposition of entry restrictions and common carrier service obligations in Ontario raises the threshold costs of efficient operation for these carriers. However, this is contradicted by the relatively low optimum

TABLE 22

Distribution of Intraprovincial, General Freight Study Carriers

Number of Shipments (000's)	Quebec	Ontario	Alberta	
0 - 10	18	18	11	
10 - 20	9	11	8	
20 - 30	4	6	3	
30 - 40	6	3	1	
40 - 50	3	1	4	
50 - 60	3	2	1	
60 - 70	3	2	0	
70 - 80	1	0	0	
80 - 90	0	1	0	
90 - 100	0	0	0	
100 - 200	3	5	0	
200 - 300	1	1	0	
300 - 400	0	1	0	
400 - 500	0	0	0	
500 - 1 000	0	1	0	
Number of Study Carriers	51	52	28	Total 131

TABLE 23

Means and Standard Deviations of Selected Variables for Intraprovincial, General Freight Carriers

Variable	Unit	Quebec		Ontario		Alberta	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Total cost	$000	1 850	2 460	2 677	3 673	517	403
Total revenue	$000	1 872	2 381	2 754	3 770	544	421
Operating ratio[a]	%	96.4 (98.8)	9.1	96.4 (97.2)	5.3	94.6 (95.0)	15.3
Total shipments		34 447	46 417	50 439	90 817	17 142	16 798
Average shipment weight	kg	3 118	4 508	6 453	7 264	5 549	7 736
Average length of haul	km	292.83	207.56	194.69	139.98	271.92	141.59
Range of average length of haul	km	27 to 1 027	N/A	26 to 684	N/A	75 to 578	N/A
Percentage LTL shipments	%	82.3	26.6	71.5	32.7	69.57	41.5
Percentage short-haul shipments	%	48.0	b	62.3	b	35.8	b
Labour cost per employee	$	10 934	2 769	13 072	4 004	11 472	2 417
Fuel & tax cost per litre	$¢¢	.161[c]	b	.128[d]	.027	.174	.229
Capital cost	$¢¢	1.57	.82	1.91	2.45	2.25	2.21
Utilization (tonne-kilometres per power unit)	000	341.609[e]	291.219	815.813[d]	1 280.103	703.475	1 452.639

[a] Arithmetic average, weighted ratio in parentheses.

[b] Not computed.

[c] Excludes single outlier which reported fuel cost as $13.20/L.

[d] Excludes four carriers that didn't report sufficient data.

[e] Excludes single carrier for which UTIL could not be calculated.

size estimated for Quebec. On the other hand, since the average cost curve appears to be rising for the largest 20 per cent of the carriers in Alberta and Quebec, it is tempting to infer that they are operating inefficiently. However, the confidence intervals bounding the average cost curves are sufficiently broad that one need not accept the hypothesis of a rising average cost curve. Since the functional form employed assumes a U-shaped average cost curve, if costs fall over some range of very small firms, costs must rise for very large firms. The mere fact that there are carriers existing above and well below optimum scale in unregulated Alberta suggests that factors not measured in the model (i.e., volume of traffic demand, demand fluctuations or quality of service) may influence the optimal scale.

Our only a priori expectation with regard to the revenue model is that rates should reflect relative costs and, therefore, the relationships observed between cost and the variables studied here should be mirrored in the revenue model. In fact, this is what is found with no significant exceptions.

A Comparison of Provincial Performance

The primary objective of this study is to measure performance. In order to measure relative performance between differently regulated environments, we can estimate the cost and revenue associated with a defined bundle of services and operating conditions.

As the environment changes so may the relationship between the performance of regulated and unregulated carriers. For example, the elasticity of cost with respect to average weight of shipments is substantially higher for Alberta carriers than for Ontario carriers. Consequently, it would be desirable to develop an overall measure of the relative performance of regulated to unregulated carriers. This may be achieved by pooling the carriers of both the regulated and unregulated provinces in the pairwise comparison and adding a dummy variable representing the presence (value equals one) of regulation or its absence (value equals zero). The estimated coefficients for equations 5, 6 and 7, modified to include a dummy variable whose value is "one" if an Alberta carrier, "zero" otherwise, are displayed in Tables 24 to 29 for revenue and costs. The F statistics to test the significance of the intercept effect are shown in Table 30. The majority of the intercepts are significant for the cost and revenue models that combine Alberta with Ontario and Alberta with Quebec at the one per cent level. This test is conditioned on the assumption of a common set

TABLE 24

Coefficients of Revenue Model with Regulatory Variable for Intraprovincial, General Freight Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	1.3069	0.6282
c_o	0	-1.8815	- .8383
		(0.3804)[a]	(.3552)
c_{oo}	0^2	0.1349	.0724
		(0.0207)	(.0195)
b_1	AWT	0.3278	.3569
		(0.0596)	(.0653)
b_2	AHAUL	0.1032	.0448
		(0.0840)	(.1229)
b_3	PLTL	0.1308	.2012
		(0.0637)	(.0705)
a_1	WAGE	0.7723	.3965
		(0.2222)	(.2972)
R	Alberta	-0.3778	- .5515
		(0.1206)	(.1769)
R^2		84.82	77.46
R^2 adjusted		83.32	75.27
N		79	80

[a] Standard errors in parentheses.

TABLE 25

Coefficients of Cost Model with Regulatory Variable for Intraprovincial, General Freight Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	1.4779	0.7367
c_o	0	-1.8311	- .8860
		(0.4085)[a]	(.3607)
c_{oo}	0^2	0.1239	.0754
		(0.0222)	(.0198)
b_1	AWT	0.3504	.3784
		(0.0640)	(.0663)
b_2	AHAUL	0.0921	.0267
		(0.0902)	(.1248)
b_3	PLTL	0.1118	.2086
		(0.0684)	(.0716)
a_1	WAGE	0.7021	.3856
		(0.2386)	(.3018)
R	Alberta	-0.3889	- .5515
		(0.1295)	(0.1797)
R^2		83.41	77.54
R^2 adjusted		81.78	75.36
N		79	80

[a] Standard errors in parentheses.

TABLE 26

Coefficients of Revenue Model with Regulatory Variable for Intraprovincial, General Freight, LTL Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	3.5324	0.2274
c_o	0	-2.1124	- .5969
		(0.5142)[a]	(.5074)
c_{oo}	0^2	0.1456	.0582
		(0.0272)	(.0267)
b_1	AWT	0.3093	.3149
		(0.0773)	(.0774)
b_2	AHAUL	0.2820	.0927
		(0.1077)	(.1397)
a_1	WAGE	0.6448	.4401
		(0.2469)	(.3987)
R	Alberta	-0.3233	- .6758
		(0.1619)	(0.2304)
R^2		86.23	81.70
R^2 adjusted		84.80	79.26
N		65	52

[a] Standard errors in parentheses.

TABLE 27

Coefficients of Cost Model with Regulatory Variable for Intraprovincial, General Freight, LTL Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	3.8400	0.5833
c_o	0	-2.1256	- .6863
		(0.5545)[a]	(.5295)
c_{oo}	0^2	0.1479	.0636
		(0.0293)	(.0279)
b_1	AWT	0.3101	.3330
		(0.0833)	(.0808)
b_2	AHAUL	0.2617	.0829
		(0.1160)	(.1457)
a_1	WAGE	0.6066	.4302
		(0.2659)	(.4160)
R	Alberta	-0.3742	- .6944
		(0.1744)	(0.2407)
R^2		85.09	81.16
R^2 adjusted		83.55	78.65
N		65	52

[a] Standard errors in parentheses.

TABLE 28

Coefficient Estimates of Revenue Model with Regulatory Variable for Intraprovincial, General Freight, Common Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	-0.4242	-1.5735
c_o	0	-2.0130	-0.3714
		(0.5087)[a]	(0.4088)
c_{oo}	0^2	0.1423	0.0546
		(0.0267)	(0.0217)
b_1	AWT	0.3984	0.3921
		(0.0709)	(0.0652)
b_2	PLTL	0.2590	0.1278
		(0.1238)	(0.0830)
a_1	WAGE	0.9557	0.3545
		(0.2453)	(0.3078)
R	Alberta	-0.2995	-0.4961
		(0.1493)	(0.1700)
R^2		85.84	80.80
R^2 adjusted		84.42	78.75
N		67	63

[a] Standard errors in parentheses.

TABLE 29

Coefficient Estimates of Cost Model with Regulatory Variable for Intraprovincial, General Freight, Common Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	-0.3578	-1.9736
c_o	0	-2.0485	-0.4136
		(0.5410)[a]	(0.4181)
c_{oo}	0^2	0.1454	0.0574
		(0.0284)	(0.0222)
b_1	AWT	0.0226	0.4188
		(0.0754)	(0.0667)
b_3	PLTL	0.2763	0.1508
		(0.1317)	(0.0849)
a_1	WAGE	0.9197	0.3736
		(0.2609)	(0.3148)
R	Alberta	-0.3155	-0.5074
		(0.1587)	(0.1739)
R^2		85.09	81.02
R^2 adjusted		83.60	78.99
N		67	63

[a] Standard errors in parentheses.

TABLE 30

F Statistics for Intercept Coefficients

Alberta and	Carrier Group	Model	
		Revenue F	Cost F
Quebec	Combined	9.811*	9.018*
Ontario	Combined	9.713*	9.547*
Quebec	LTL	3.99***	4.605**
Ontario	LTL	8.606*	8.346*
Quebec	Common	4.026**	3.95***
Ontario	Common	8.513*	8.513*

* Significant at the .01 level.
** Significant at the .05 level.
*** Significant at the .075 level.

TABLE 31

Ratio of Regulated Carrier Revenues and Costs to Alberta Carrier Rates and Costs -- Pooled Model

Alberta and	Carrier Group	Model	
		Revenue[a]	Cost[a]
Quebec	Combined	1.41	1.47
Ontario	Combined	1.73	1.73
Quebec	LTL	1.38	1.45
Ontario	LTL	1.96	2.00
Quebec	Common	1.35	1.37
Ontario	Common	1.64	1.66

[a] if $R>0$, ratio = $\exp.(R)$;
if $R<0$, ratio = $\frac{1}{\exp.(R)}$

of slope coefficients. The hypothesis of homogeneous slopes could not be rejected at the five per cent level using an analysis of covariance test (see Appendix B). The covariance test does not compare individual slopes, but the vector of slopes between the provincial regressions. It appears, then, that Ontario and Quebec carriers are less efficient and charge higher rates overall. The relative performance of trucking in these provinces is summarized in Table 31. The identical impact of the revenue and cost intercept effects suggests that Ontario and Quebec carriers are less efficient than Alberta carriers, rather than their being monopolists earning excess profits. Ontario carriers appear to perform poorly relative to Quebec carriers and it appears that LTL carriers (as opposed to TL) in Ontario are at the greatest disadvantage relative to unregulated trucking.

The foregoing comparison is consistent with previous observations that the performance of Alberta carriers is superior to that of Ontario and Quebec carriers.[2] However, the differences in provincial performance are also influenced by the choice of the "average" firm utilized in each pairwise comparison. For example, the average firm size of Alberta carriers is 17 000 shipments (see Table 23), a figure significantly less than the estimated optimal firm size of Alberta carriers. Consequently, if we estimated firm performance at a much larger firm size, we would expect the Alberta performance to improve as would be the case in Ontario and Quebec as well.

The potential effect of scale choice on relative performance of each province is illustrated by plotting the long run average cost and revenue curves of carriers in Alberta and in each of the regulated provinces from 2 000 to 100 000 shipments. The coefficients of the combined carrier group (equation 5) are utilized and in Table 33 the observed relationships are summarized. The average characteristics (except scale) of the output and factor price vectors are found in Table 32.

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[2] See McRae and Prescott, Effects of Regulation, p. 70.

TABLE 32

Average Output and Operating Characteristics

Average Values for Alberta and Regulated Provinces		
Output and Factor Price Definition	Comparison of Alberta with	
	Ontario	Quebec
Total shipments	38 785	28 313
Average weight (kg)	6 137	3 979
Average haul (km)	222	286
Per cent LTL	67.2	77.8
Per cent general freight revenue service	.925	.961
Fuel cost $ per litre	.143[a]	.165[b]
Wage cost $	12 512.00	11 125.00
Capital cost $	2.03	1.81
Utilization tonne-kilometres per power unit (000)	774.425[a]	471.510[c]
N	80	79

[a] Excludes four Ontario carriers which did not report utilization of fuel data.

[b] Excludes one Quebec outlier carrier whose fuel cost was reported as $13.20/L.

[c] Excludes one Quebec carrier which reported no utilization data.

TABLE 33

Behaviour of Regulated Provincial Performance Relative to Alberta as a Function of Firm Size

	Revenue[a]	Cost[b]
Quebec	is less than Alberta revenue up to 2 000 shipments; thereafter exceeds Alberta revenue throughout range	is less than Alberta costs up to 33 000 shipments; thereafter exceeds Alberta cost throughout range
Ontario	exceeds Alberta revenue up to 93 000 shipments; thereafter is less	exceeds Alberta cost up to 73 000 shipments; thereafter is less

[a] Estimated from coefficients in Table 14.
[b] Estimated from coefficients in Table 17.

The results confirm that Quebec performs poorly relative to Alberta in terms of rates but appears to be cost efficient up to 33 000 shipments. In contrast, Ontario costs become less than Alberta costs at a size of approximately 73 000 shipments, and Ontario revenues continue to exceed Alberta revenues up to 93 000 shipments. The significance of these comparisons is best seen by referring to the size of carriers presently operating in each province, displayed in Table 22. It appears that Alberta carriers actually operate at a scale where their costs are less than those of Ontario carriers. In contrast, the bulk of Quebec traffic is moved by carriers exceeding the scales at which they are more efficient than Alberta carriers. Thus, given the behaviour of costs, Alberta carriers operate in a size range where their costs are the lowest.[3]

This type of comparative analysis could be extended to compare provincial rates and costs across a continuum of the other variables such as average shipment weight, per cent LTL, average haul and so on. However, we must be careful to distinguish between visual conclusions and a statistically supportable hypothesis. Since we cannot statistically reject the null hypothesis of homogeneous slope vectors, we can validly use the value of the dummy regulation variables as a measure of the overall effect of regulation, holding other modeled factors constant. As shown in Table 31, these effects are quite large and statistically significant.

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[3] This statement is true for the sample of carriers studied. The representativeness of the sample for the general freight carrier population is discussed in Chapter VI.

The Impact of Utilization Economies on Performance

An issue that has been controversial in the measurement of economies of scale in many industries is whether the proper specification of the long run cost model (or production function) should include a capacity utilization measure. For example, Harmatuck notes the confusion regarding scale and utilization economies in the railroad industry.[4] Spady and Friedlaender conclude that larger firms can achieve greater economies of density and utilization than smaller firms, and that it is likely that these observed economies derive from features of the regulatory environment rather than from the underlying technology of trucking.[5] This author posits that better utilization of trucking capacity is a function of size per se.[6] Finally, a third determinant of utilization level is the density and composition of traffic available to the carrier.

The question as to whether a utilization variable should be included in the cost model depends on which viewpoint is accepted as most valid and on the objectives of the research. If the cause of higher or lower utilization is an exogenous factor (i.e., traffic mix and demand differences), such a variable is properly included, since it would reflect the influence of a noncontrollable factor. On the other hand, if utilization is a function of endogenous factors such as firm size, the benefits of firm size would be hidden by the inclusion. Finally, if utilization is a function of regulation, then equalization of utilization would disguise the impact of regulation. (This argument is similarly applied to labour prices.)

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[4] D.J. Harmatuck, "A Policy-Sensitive Railway Cost Function," Logistics and Transportation Review 15, no. 2 (1978), pp. 279-80.

[5] R.H. Spady and A.F. Friedlaender, "Hedmic Cost Functions for the Regulated Trucking Industry," Bell Journal of Economics 9, no. 1 (Spring 1978), pp. 172-73.

[6] G. Chow, "The Status of Economies of Scale in Regulated Trucking: A Review of the Evidence and Future Directions," Proceedings -- Nineteenth Annual Meeting of Transportation Research Forum 17, no. 1 (1978b), pp. 365-73.

Since there are wide differences of opinion on the validity of one viewpoint versus another, the cost model was re-evaluated with a utilization measure (UTIL) to test the sensitivity of the previous observations. Average loads has been used in the past but it only measures one dimension of utilization, weight capacity of vehicle. Tonne-kilometres per power unit has the advantage of measuring both the weight and distance capacity of a vehicle over time, of the motor carrier's largest class of assets. The results of the cost model recalibrated on the combined carrier group (equation 5) with this measure are shown in Table 34. The signs of the utilization coefficient are negative as we would expect.

The optimum scale for Quebec, Ontario and Alberta carriers is calculated to be 32 724, 258 644 and 31 945 shipments respectively. Referring to Table 21, the optimum level of output is reduced slightly in Quebec and Alberta and significantly in Ontario. It is difficult, however, to conclude that utilization is related solely to firm size. The simple correlation coefficient between the log of utilization and the log of shipments is .39, .36 and -.15 in Quebec, Ontario and Alberta respectively. As discussed earlier, the level of utilization is potentially a function of several factors.

Costs are again plotted and compared over a scale range of 2 000 to 100 000 shipments. Summarized briefly, we find that: (1) Quebec costs exceed Alberta costs up to 3 000 shipments and thereafter are less, and (2) Ontario costs exceed Alberta costs up to 56 000 shipments and thereafter are less. This reversal in performance relationships between Quebec and Alberta is expected. Quebec carriers are characterized as having less than half the average utilization of capacity found for Alberta carriers (see Table 23). By equalizing utilization levels between the carriers of the two provinces, Quebec carriers are made to appear more efficient than they actually are and Alberta carriers are made to appear less efficient. The point needs to be stressed that utilization is a function of several factors. If market-demand influences on utilization are the basis for differences in utilization levels between provinces, there would be justification for equalizing such differences in the comparison of performance. On the other hand, if the utilization level is influenced by differences in economic regulation, equalization of utilization levels would disguise the impact of regulation.

TABLE 34

Coefficient Estimates for Cost Model with Utilization Specification for Intraprovincial, General Freight Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	2.0783	-0.6921	-0.3298
c_o	0	-1.9254	- .3211	-1.3295
		(0.6012)[a]	(.5255)	(0.6162)
c_{oo}	0^2	0.1407	.0530	0.1123
		(0.0318)	(.0281)	(0.0329)
b_1	AWT	0.3413	.4860	0.6333
		(0.1160)	(.0937)	(0.1063)
b_2	AHAUL	0.1497	.1058	0.4115
		(0.1334)	(.1637)	(0.1924)
b_3	PLTL	0.0229	.2007	0.2150
		(0.0942)	(.0914)	(0.0997)
a_1	WAGE	0.7285	.1268	0.2361
		(0.3305)	(.3825)	(0.3599)
U	UTIL	-0.0869	- .1601	-0.2258
		(0.0770)	(0.0506)	(0.1171)
R^2		83.03	76.11	84.07
R^2 adjusted		80.27	72.31	78.50
N		51	52	28

[a] Standard errors in parentheses.

As noted above, these visual observations are not necessarily statistically significant. Furthermore, the utilization issue cannot be conclusively answered from the data available to this study.[7] However, an alternative approach to estimating the impact of regulation without ignoring utilization is to use an indicator variable directly in the model. The results of the pooled cost model are displayed in Table 35 for the combined carrier group. The coefficients for the dummy variable representing Alberta carriers are significant at the five per cent level and indicate that Quebec and Ontario carrier costs overall are 33 and 42 per cent higher than Alberta carrier costs. Comparison of these cost inefficiencies with those found in Table 31 indicates that the relative efficiency of Alberta carriers is reduced when utilization is accounted for; nonetheless, Alberta carriers still retain a statistically significant advantage in cost efficiency.

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[7] The empirical measurement of factors affecting utilization is discussed in Appendix C.

TABLE 35

Coefficient Estimates of Pooled Cost Model with Utilization and Regulatory Variables for Intraprovincial, General Freight Carriers

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	0.0561	0.1899
c_o	0	-1.5654	- .7896
		(0.4171)[a]	(.3312)
c_{oo}	0^2	0.1228	.0766
		(0.0223)	(.0181)
b_1	AWT	0.4551	.5021
		(0.0791)	(.0686)
b_2	AHAUL	0.2203	.1530
		(0.1062)	(.1189)
b_3	PLTL	0.1106	.1818
		(0.0667)	(.0659)
a_1	WAGE	0.6016	.2446
		(0.2374)	(.2787)
U	UTIL	-0.1311	- .1624
		(0.0609)	(.0421)
R	Alberta	-0.2909	- .3532
		(0.1342)	(0.1727)
R^2		84.44	81.43
R^2 adjusted		82.67	79.34
N		79	80

[a] Standard errors in parentheses.

Chapter V

A FURTHER ANALYSIS OF INTRAPROVINCIAL TRUCKING PERFORMANCE

The focus of the analysis described in Chapter IV was on intraprovincial general freight carriers. This chapter tests the sensitivity of those results to variations in population definition and model formulation. This sensitivity analysis allows us to test the robustness of the initial conclusions.

Comparisons of Regression Results Between GF and NGF Populations

The study has so far concentrated on carriers which earn the majority of their revenues from the movement of general freight. The homogeneity of this group of carriers has several advantages. General freight carriers tend to utilize the same technology (i.e., equipment and operating techniques) and face similar operating conditions. The same is true for any class of carrier identified by commodity. A carrier whose principal products moved are petroleum, autos, refrigerated liquid or dry bulk in tanks utilizes specialized equipment and usually makes one-way hauls (or obtains back-hauls through circuitous backrouting and expensive equipment sanitization). Carriers such as those transporting general freight utilize general purpose vans suitable for the movement of a wide variety of products. Consequently, a comparison of performance that doesn't recognize commodity heterogeneity may be identifying spurious relationships. The emphasis on one group of carriers also has the advantage of isolating the effects of regulation. As noted in the House report, regulations differ significantly between segments of the industry.[1] It would be inappropriate, for example, to mix dump truck firms with GF carriers as dump trucking was unregulated in 1975 (and may still be de facto unregulated today).[2]

It would be desirable to duplicate the steps taken in analyzing the performance of GF carriers for each type of NGF carrier. However, this is not possible due to the small population and subsequently small number of sample observations available for each type of specialized carrier. We thus resort to grouping all NGF carriers into one class.

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[1] "Economic Regulation," p. 150.

[2] Ibid., Appendix D.

TABLE 36

Coefficient Estimates for Cost Model of Intraprovincial, Nongeneral Freight Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	-8.0061	-1.9467	-21.6643
c_o	0	-0.4812	-0.8061*	2.1784
		(0.5494)[a]	(0.4798)	(1.7308)
c_{oo}	0^2	0.0614*	0.0839*	-0.1330*
		(0.0373)	(0.0297)	(0.1367)
b_1	AWT	0.6570*	0.0296	1.0953*
		(0.1136)	(0.1340)	(0.3979)
b_2	AHAUL	0.2611*	-0.0434	0.0329
		(0.1645)	(0.2099)	(0.3346)
b_3	PLTL	0.2075*	-0.1742*	0.2385
		(0.0702)	(0.1170)	(0.1574)
a_1	WAGE	0.6307	0.9727*	0.7619*
		(0.4092)	(0.5095)	(0.3636)
R^2		70.38	59.82	61.69
R^2 adjusted		64.65	52.93	48.92
N		38	42	25

* Significant at the .05 level.

[a] Standard errors in parentheses.

TABLE 37

Coefficient Estimates for Revenue Model of Intraprovincial, Nongeneral Freight Carriers

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	-8.2236	-0.5457	-21.3756
c_o	0	-0.4782	- .8636*	2.3414
		(0.5793)[a]	(.4950)	(1.7128)
c_{oo}	0^2	0.0602	.0834*	-0.1462
		(0.0393)	(.0307)	(0.1353)
b_1	AWT	0.6452*	.0256	1.0210*
		(0.1197)	(.1382)	(0.3938)
b_2	AHAUL	0.2118	- .0959	0.0673
		(0.1734)	(.2165)	(0.3311)
b_3	PLTL	0.2054*	- .1583	0.2119
		(0.0740)	(.1207)	(0.1558)
a_1	WAGE	0.7034*	.8970*	0.7524*
		(0.4314)	(0.5257)	(0.3598)
R^2		67.0	55.79	61.02
R^2 adjusted		6.6	48.21	48.02
N		38	42	25

* Significant at the .05 level.

[a] Standard errors in parentheses.

Equation 5 was calibrated for nongeneral freight (NGF), intraprovincial carriers in each province. Both the cost and revenue formulations were estimated and the coefficients for these models are displayed in Tables 36 and 37. These tables are compared to Tables 14 and 15 in Chapter IV. It is evident that a greater proportion of variance in cost and revenue of GF carriers is explained by the models vis-à-vis the NGF carriers. No doubt this is partially due to the smaller sample size of the NGF carrier group. However, a substantial proportion of the unexplained variance in the NGF models is probably due to the greater heterogeneity of the NGF carrrier samples. In addition, many of the coefficients will either be significant or take on a specific value for the NGF group. For example, the "percentage of LTL" is not an important determinant of Quebec-GF carrier cost but it is an important determinant of Quebec-NGF carrier cost. This suggests that a different model utilizing different independent variables may be more appropriate for one set of carriers (NGF) than another (GF). This was found to be the appropriate approach in Chapter IV where models were utilized for increasingly homogeneous groupings of carriers (i.e., from all intraprovincial to common carriers to LTL carriers).

The remainder of this analysis of NGF carriers will continue to utilize equation 5 for comparative purposes. Both a pooled model and a pooled model with a dummy variable representing Alberta were estimated for a combined Quebec-Alberta sample and for a combined Ontario-Alberta sample. The coefficients for the pooled cost model (with a regulation variable) are displayed in Table 38 as representative of the results. In both the cost and revenue formulations of the pooled model, the intercept effect represented by the coefficient of the dummy variable was not significantly different from zero at the five per cent level of significance. This result contrasts with the results for the GF carriers in Tables 24 and 25 where the regulatory effect is significant. It appears that regulation may have a different impact on different segments of the industry. One plausible explanation of the present comparison is that the NGF carriers tend to be represented by truckload carriers which are less stringently controlled by government regulation, vis-à-vis market forces. Consequently, NGF carriers in Ontario and Quebec perform comparably with NGF carriers in Alberta. Furthermore, selected carriers in the NGF category may not be regulated in Ontario or Quebec for the year observed. The dump truckers are a case in point in Ontario.

The cost formulation of the above models was estimated with the inclusion of a utilization variable. Utilization significantly affected the cost performance. However, none of the conclusions made above were affected.

TABLE 38

Coefficients of Pooled Cost Models for Nongeneral Freight Carriers

Coefficient	Variable	Alberta with Quebec	Alberta with Ontario
a_o	Constant	-11.0194	-6.6118
c_o	0	0.1069	-0.1548
		(0.5113)[a]	(0.4096)
c_{oo}	0^2	0.0249	0.0453
		(0.0359)	(0.0267)
b_1	AWT	0.6813	0.2380
		(0.1223)	(0.1220)
b_2	AHAUL	0.2302	0.0926
		(0.1538)	(0.1699)
b_3	PLTL	0.1974	-0.0249
		(0.0697)	(0.0904)
a_1	WAGE	0.6969	0.8745
		(0.2422)	(0.2876)
R	Alberta	-0.0420	0.2304
		(0.1960)	(0.2529)
R^2		64.34	55.11
R^2 adjusted		59.80	49.78
N		63	67

[a] Standard errors in parentheses.

TABLE 39

Coefficient Estimates for Cost Model of Intraprovincial Carriers -- Pooled and Non-Pooled Models

Coefficient	Variable	Quebec	Ontario	Alberta	Quebec with Alberta	Ontario with Alberta
a_o	Constant	-3.9184	-3.9803	-8.3761	-5.9711	-5.0513
c_o	0	-0.9122	-0.2863	-0.0391	-0.5496	-0.2134
		(0.2946)[a]	(0.3061)	(0.4892)	(0.2364)	(0.2374)
c_{oo}	0^2	0.0866	0.0478	0.0375	0.0671	0.04339
		(0.0172)	(0.0173)	(0.0324)	(0.0143)	(0.0140)
b_1	AWT	0.4523	0.2661	0.5251	0.4904	0.3184
		(0.0735)	(0.0704)	(0.1140)	(0.0602)	(0.0581)
b_2	AHAUL	0.1469	-0.0623	0.1556	0.1720	-0.0012
		(0.0947)	(0.1265)	(0.1753)	(0.0841)	(0.1024)
b_3	PLTL	0.1215	0.0914	0.1146	0.1195	0.0830
		(0.0529)	(0.0672)	(0.0845)	(0.0447)	(0.0535)
a_1	WAGE	0.6887	0.7304	0.6701	0.6845	0.7362
		(0.2556)	(0.3171)	(0.2590)	(0.1724)	(0.2070)
R	Alberta				-0.2049	-0.2053
					(0.1142)	(0.1495)
R^2		75.75	64.92	58.48	72.14	65.45
R^2 adjusted		73.98	62.50	53.07	70.69	63.71
N		89	94	53	142	147

[a] Standard errors in parentheses.

The cost models were next calibrated on the intraprovincial carriers without any distinction between the GF and NGF carriers. The results of both the unpooled and pooled estimations (with the indicator variable) are displayed in Table 39. The results are consistent with the expectations. Alberta performance is significantly superior to Quebec performance as indicated by the significantly negative coefficient for the regulatory dummy variable. In contrast, this coefficient is not significant for the pooled Ontario-Alberta model. In both cases, the coefficients of the regulatory variable appear to be an average for the GF and NGF regulatory effect shown in Tables 17 and 38.

This analysis suggests that the segmentation of GF from NGF carriers was justified. Combining the two populations would have resulted in the averaging of distinctly different types of carriers which are potentially regulated differently as well.

Sensitivity of Regression Results to Population and Model Specifications

This study has sought to isolate the impact of regulation by focusing on a homogeneous population of motor carriers, the intraprovincial, general freight carriers. The criteria used to identify carriers in this group were:

(1) the carrier earned 100 per cent of its revenues in intraprovincial movement;

(2) the carrier earned 50 per cent or more of its revenues in the movement of general freight.

This study implemented these criteria by utilizing statistics reported in the Motor Carriers-Freight Survey (MCF) tapes. However, it is pointed out that these figures are estimates which are inconsistent with estimates of the same criterion variables made from the For-Hire Trucking Origin and Destination Survey (TOD) tapes. It should be stressed that the carrier characteristics identified from either source (MCF or TOD) are estimates. In many situations it appears that a carrier reports in the MCF survey that no extraprovincial revenues are earned, yet extraprovincial freight bills are sampled for the firm in the TOD survey. Where the TOD-estimated percentage of extraprovincial business is small, this would suggest that the carrier didn't consider its extraprovincial business significant enough to highlight. In addition, because the TOD figures are estimates, they may over- or underestimate the true value.

It was noted in Chapter III that further homogeneity in the carrier population could be obtained by concentrating the analysis on intercity carriers to the exclusion of carriers predominantly in local service. Again, the carrier samples could be identified using data from either the TOD or the MCF surveys.

The criticism could also be made that the general freight category is in itself heterogeneous. It would probably be beneficial to segment the carriers by greater commodity detail (i.e., as used in McRae and Prescott[3]). However, the balance between available observations and homogeneity would have to be considered, and it is likely that this general criterion will have to do. We can at least state that there is more homogeneity in this sample than in comparable analysis at the firm level where no distinctions are made at all.

The original sample was purged to test the sensitivity of the original results to changes in the sample based on the concerns expressed above. Estimates of the percentage of extraprovincial revenues for Alberta were estimated from the TOD survey by the Canadian Transport Commission (CTC).[4] Using the CTC estimates, two Alberta carriers with 20 per cent or more extraprovincial business were deleted from the sample as it was felt that a carrier with 80 per cent or more of its business in the intraprovincial area was sufficiently homogeneous. The remaining 26 carriers were distributed as follows: 15 with 0 per cent extraprovincial revenue, 10 with 1 to 10 per cent and 1 with 11 to 20 per cent.

The CTC also estimated, based on the TOD survey, the percentage of revenues earned for shipments travelling less than 24.1 km for Ontario and Quebec, but not for Alberta. It would be inappropriate to delete the local carriers in two provinces and not the third. Therefore, estimates of the local proportion of business for Alberta carriers were estimated from the MCF survey. There was enough agreement between the two surveys to proceed. Subsequently, seven Ontario, seven Quebec and four Alberta carriers were identified as carriers with local revenues exceeding 30 per cent of the business and deleted from the provincial samples.

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[3] Effects of Regulation.

[4] This analysis was conveyed via Andrew Klymchuk, Consumer and Corporate Affairs Canada, letter dated October 20, 1980.

In summary, the carrier deletions made above increase the homogeneity of the original sample and its validity with respect to measuring differences in carrier performance between provinces. The population may now be titled "general freight, nonlocal, intraprovincial carriers."[5]

The sensitivity of the original results to sample changes was initially tested by calibrating the provincial and pooled models (if appropriate) using a sample reduced by deleting the 2 Alberta carriers with over 20 per cent extra-provincial revenues and 14 Ontario, Quebec and Alberta local carriers with over 30 per cent local revenues. The results of the pooled cost model for Quebec merged with Alberta are shown in Table 40.

Four major observations were made:

1. The coefficient for AHAUL was generally found to be insignificant in the original cost models but is now significant or more significant in four of the six provincial models where the variable was included (Quebec - all GF, Alberta - all GF, Ontario - LTL, Alberta - LTL). This was also observed in the pooled models. In Table 40, the coefficient of AHAUL increases from .09 to .36 without a change in the standard error. The deletion of the local carriers probably led to this improvement. This suggested inclusion of AHAUL in analyzing the common carrier group.

2. The coefficient for WAGE was found to be insignificant in every provincial cost model and in the pooled model as shown in Table 40. This suggests a respecification of the model to delete WAGE.

3. The goodness of fit of the models (as measured by the R^2) increased. This occurred despite a reduction in sample size. The sample is obviously more homogeneous. For example, the R^2 increased from 83.4 to 87.7 for the pooled Alberta-Quebec model.

4. The performance differential between Ontario and Alberta decreased slightly but the difference was still significant. The performance difference between Alberta and Quebec decreased significantly, from -.38 to -.20 as shown in Table 40. However, while adjustments had been made to

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[5] The elimination of the carrier with workload number 6125 removes the carrier identified by the CTC to be domiciled in British Columbia but listed as a carrier doing business in Quebec in the MCF survey. Ibid.

TABLE 40

Sensitivity Analysis of Pooled Cost Model Results to Sample and Variable Deletions (Alberta Carriers Merged with Quebec)

Coefficient	Variable	(1) Original Model[a] Original Sample	(2) Original Model Reduced Sample[b]	(3) Reduced Model[c] Reduced Sample	(4) Reduced Model Equalized Sample[d]
a_o	Constant	1.4779	3.4945	4.5300	1.5393
C_o	0	-1.8311 (0.4085)	-1.4253 (0.3953)	-1.4212 (0.3931)	-0.7508 (0.4666)
C_{oo}	0^2	0.1339 (0.0222)	0.1142 (0.0212)	0.1143 (0.0211)	0.0801 (0.0246)
b_1	AWT	0.3504 (0.0640)	0.3345 (0.0575)	0.3390 (0.0566)	0.3071 (0.0565)
b_2	AHAUL	0.0921 (0.0902)	0.3654 (0.0997)	0.3811 (0.0954)	0.4092 (0.0937)
b_3	PLTL	0.1118 (0.0684)	0.0966 (0.0686)	0.0997 (0.0680)	0.0527 (0.0690)
a_1	WAGE	0.7021 (0.2386)	0.1310 (0.2273)		
R	Alberta	-0.3889 (0.1295)	-0.2047 (0.1211)	-0.1853 (0.1158)	-0.2507 (0.1166)
R^2		83.41	87.67	87.60	88.06
N		79	70	70	66

[a] Table 25.

[b] Quebec sample adjusted from data given by CTC to eliminate local carriers. Alberta sample adjusted to exclude interprovincial carriers.

[c] Wage as independent variable deleted.

[d] Alberta sample adjusted from MCF survey to eliminate local carriers.

the Quebec and Ontario samples to reduce local carrier representation, the same had not been done to the Alberta sample.

A second set of supplemental regressions was calibrated to test the impact of deleting the variable WAGE. The impact was minimal as can be seen by comparing columns 3 and 2 of Table 40.

The third and final set of supplemental regressions made three adjustments simultaneously:

1. the Alberta sample was also purged of predominantly local carriers;

2. the variable WAGE was deleted from all models;

3. the variable AHAUL was added to the common carrier models.

The regression results are displayed in Tables 41 to 51 where each table corresponds to the respectively numbered table (in parentheses) in Chapter IV.

The following conclusions are made from a comparison of the supplementary and original analysis:

1. The deletion of predominantly local carriers from each provincial sample increased the homogeneity of the study carriers. The R^2 increased despite reducing the sample size and deleting the variable WAGE.

2. Apparently the inclusion of local carriers disguised the importance of length of haul. The variable AHAUL is significant in the majority of the models including the common carrier model which previously did not include AHAUL. For some reason AHAUL is not significant in the Ontario models.

3. The coefficients for AWT and PLTL are relatively stable. However, the scale coefficients (0 and 0^2) vary considerably. Examination of Table 21 indicates that the computed optimal scale is very sensitive to sample variations.

4. The differential in performance between Alberta carriers and Ontario-Quebec carriers is confirmed. As shown in Tables 49 and 31, the ratio of regulated rates and costs to unregulated rates and costs decreases but the ratio still exceeds one in all cases. The largest decrease is in the

relative efficiency of Alberta to Quebec general freight carriers (combined group). As shown in Tables 48 and 30, the significance levels decline in some cases and increase in others.

5. The differential in performance between Alberta and Ontario is not changed by the sample and variable changes in the model with utilization. As shown in Tables 35 and 51, the poor performance of Ontario is actually increased. However, Quebec fares much better as the differential between Alberta and this regulated province is not statistically significant. This again points out the importance of evaluating the factors affecting utilization.

In summary, the model results are improved through the further cleansing of the sample. Some coefficients (particularly scale variables) are very sensitive to the sample makeup. However, the coefficients for the variable representing performance differentials between regulated and unregulated carriers are relatively stable and robust. The conclusions made in Chapter IV are confirmed.

TABLE 41 (17)

Coefficient Estimates for Cost Model of Intraprovincial, General Freight Carriers (Modified Model and Sample)

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	3.2797	0.2136	0.4398
c_o	0	-0.9069	- .1995	- .6120
		(0.6683)[a]	(.6205)	(.6497)
c_{oo}	0^2	0.0898	.0433	.0662
		(0.0348)	(.0328)	(.0355)
b_1	AWT	0.2471	.4123	.3794
		(0.0871)	(.0939)	(.0712)
b_2	AHAUL	0.3468	.1440	.3836
		(0.1277)	(.1749)	(.1420)
b_3	PLTL	-0.0111	.2427	.1665
		(0.1133)	(0.0926)	(0.0929)
R^2		88.29	75.90	88.48
R^2 adjusted		86.74	72.81	84.87
N		44	45	22

[a] Standard errors in parentheses.

TABLE 42 (18)

Coefficient Estimates for Cost Model of Intraprovincial, General Freight, LTL Carriers (Modified Model and Sample)

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	3.2345	3.5081	32.4248
c_o	0	-0.9102	-0.6894	-7.0958
		(0.7025)[a]	(0.6354)	(2.4428)
c_{oo}	0^2	0.0810	0.0662	0.3955
		(0.0363)	(0.0332)	(0.1262)
b_1	AWT	0.2465	0.3297	0.6001
		(0.0875)	(0.0992)	(0.1451)
b_2	AHAUL	0.3501	0.2628	0.6001
		(0.1357)	(0.1824)	(0.1451)
R^2		87.85	85.14	92.72
R^2 adjusted		86.54	82.44	89.80
N		42	27	15

[a] Standard errors in parentheses.

TABLE 43 (19)

Coefficient Estimates for Cost Model of Intraprovincial, General Freight, Common Carriers (Modified Model and Sample)

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	0.3771	-0.4070	4.9549
c_o	O	- .7393	- .4215	-2.0095
		(.7038)[a]	(.6241)	(1.1284)
c_{oo}	O^2	.0828	.0612	0.1342
		(.0365)	(.0336)	(0.0579)
b_1	AWT	.3332	.4769	0.4826
		(.1097)	(.1080)	(0.0859)
b_2	PLTL	.3030	.1983	0.5187
		(.4089)	(.0989)	(0.2308)
b_3	AHAUL	.3738	.1986	0.4495
		(0.1373)	(0.1790)	(0.1324)
R^2		88.74	81.10	91.35
R^2 adjusted		87.03	77.72	88.03
N		39	34	19

[a] Standard errors in parentheses.

TABLE 44 (21)

Optimal Firm Size (Shipments) Estimated from Modified Model and Sample

Carrier Segment	Quebec	Ontario	Alberta
Combined	40 843	1 036 167	192 504
LTL	132 106	347 952	27 858
Common carrier	36 425	110 587	74 068

TABLE 45 (25)

Coefficients of Cost Model with Regulatory Variable for Intraprovincial, General Freight Carriers (Modified Model and Sample)

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	1.5393	0.8135
c_o	0	-0.7508	- .4351
		(0.4666)[a]	(.4189)
c_{oo}	0^2	0.0801	.0550
		(0.0246)	(.0225)
b_1	AWT	0.3071	.4043
		(0.0565)	(.0667)
b_2	AHAUL	0.4092	.2055
		(0.0937)	(.1252)
b_3	PLTL	0.0527	.2197
		(0.0690)	(.0664)
R	Alberta	-0.2507	- .5298
		(0.1166)	(0.1749)
R^2		88.06	82.40
R^2 adjusted		87.06	80.64
N		66	67

[a] Standard errors in parentheses.

TABLE 46 (27)

Coefficients of Cost Model with Regulatory Variable for Intraprovincial, General Freight, LTL Carriers (Modified Model and Sample)

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	3.8713	3.7381
c_o	0	-1.0904	-0.7919
		(0.6507)[a]	(0.5391)
c_{oo}	0^2	0.0975	0.0712
		(0.0336)	(0.0281)
b_1	AWT	0.2606	0.3358
		(0.0746)	(0.0782)
b_2	AHAUL	0.4079	0.3126
		(0.1105)	(0.1340)
R	Alberta	-0.3373	-0.5943
		(0.1556)	(0.2046)
R^2		88.20	88.16
R^2 adjusted		87.04	86.52
N		57	42

[a] Standard errors in parentheses.

TABLE 47 (29)

Coefficient Estimates of Cost Model with Regulatory Variable for Intraprovincial, General Freight, Common Carriers (Modified Model and Sample)

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	0.8256	0.0731
c_o	0	- .6789	- .5425
		(.5775)[a]	(.4137)
c_{oo}	0^2	.0758	.0658
		(.0299)	(.0225)
b_1	AWT	.3469	.4594
		(.0644)	(.0716)
b_3	PLTL	.0863	.1913
		(.1330)	(.0745)
a_1	AHAUL	.4248	.2914
		(.1032)	(.1262)
R	Alberta	- .2528	- .4736
		(0.1354)	(0.1793)
R^2		89.41	87.02
R^2 adjusted		88.17	85.32
N		58	53

[a] Standard errors in parentheses.

TABLE 48 (30)

F Statistics for Intercept Coefficients (Modified Model and Sample)

Alberta and	Carrier Group	Model	
		Revenue F	Cost F
Quebec	Combined	3.990***	4.624**
Ontario	Combined	8.688*	9.174*
Quebec	LTL	4.443**	4.697**
Ontario	LTL	8.298*	8.440*
Quebec	Common	3.983***	3.486***
Ontario	Common	6.237**	6.977**

* Significant at the .01 level.
** Significant at the .05 level.
*** Significant at the .10 level.

TABLE 49 (31)

Ratio of Regulated Carrier Revenues and Costs to Alberta Carrier Revenues and Costs -- Pooled Model (Modified Model and Sample)

Alberta and	Carrier Group	Model	
		Revenue[a]	Cost[a]
Quebec	Combined	1.25	1.28
Ontario	Combined	1.69	1.70
Quebec	LTL	1.37	1.40
Ontario	LTL	1.80	1.81
Quebec	Common	1.30	1.29
Ontario	Common	1.57	1.61

[a] If $R>0$, Ratio = exp. (R);

if $R<0$, Ratio = $\frac{1}{\text{exp.}(R)}$

TABLE 50 (34)

Coefficient Estimates for Cost Model with Utilization Specification for Intraprovincial, General Freight Carriers (Modified Model and Sample)

Coefficient	Variable	Quebec	Ontario	Alberta
a_o	Constant	2.7913	-0.3402	-1.8296
c_o	0	-0.8766	- .2859	-0.3444
		(0.6726)[a]	(.5774)	(0.6587)
c_{oo}	0^2	0.0889	.0528	0.0559
		(0.0350)	(.0307)	(0.0352)
b_1	AWT	0.2863	.4875	0.4865
		(0.1003)	(.0916)	(0.1028)
b_2	AHAUL	0.3843	.1758	0.5282
		(0.1365)	(.1629)	(0.1719)
b_3	PLTL	-0.0063	.2030	0.1361
		(0.1140)	(.0873)	(0.0928)
U	UTIL	-0.0508	- .1295	-0.1439
		(0.0634)	(0.0484)	(0.1022)
R^2		88.48	79.73	89.82
R^2 adjusted		86.62	76.53	85.75
N		44	45	22

[a] Standard errors in parentheses.

TABLE 51 (35)

Coefficient Estimates of Pooled Cost Model with Utilization and Regulatory Variables for Intraprovincial, General Freight Carriers (Modified Model and Sample)

		Alberta Carriers Merged with	
Coefficient	Variable	Quebec	Ontario
a_o	Constant	0.7161	0.3695
c_o	0	- .6785	- .4867
		(.4666)[a]	(.3921)
c_{oo}	0^2	.7753	.0621
		(.0245)	(.0212)
b_1	AWT	.3722	.4842
		(.0696)	(.0675)
b_2	AHAUL	.4632	.2587
		(.1015)	(.1183)
b_3	PLTL	.0528	.1918
		(.0685)	(.0627)
U	UTIL	- .0697	- .1232
		(.0522)	(.0397)
R	Alberta	- .2069	- .3790
		(0.1204)	(0.1706)
R^2		89.25	84.87
R^2 adjusted		57.96	83.67
N		66	67

[a] Standard errors in parentheses.

Chapter VI

SUMMARY AND CONCLUSIONS

The statistical analysis described in this report made use of the firm level information from the 1975 MCF survey and aggregated shipment level data from the 1975 TOD survey. This study is different from previous comparative studies of the performance of Canadian trucking in its use of the firm as the unit of observation rather than the broader and narrower levels of aggregation used previously. This allowed the study to measure performance in terms of rates (revenues) and costs. The first comparison parallels many previous efforts to study the relationship between regulation and the prices charged for trucking services. The latter comparison allows us to differentiate between high prices due to allocative inefficiency (i.e., the earning of monopoly profits) and technical inefficiency (i.e., the inefficient use of capacity and technology).

The study sought to achieve the highest level of comparability between carriers in different provinces by concentrating the analysis on three groups: (1) general freight, intraprovincial carriers, (2) general freight, intraprovincial LTL carriers and (3) general freight, intraprovincial common carriers. Revenue and cost functions were successfully estimated for the provinces of Alberta, Quebec and Ontario. Although initially selected for study there were not enough observations to make conclusions about the performance of carriers in Manitoba, Saskatchewan and British Columbia.

The major relationship observed was the consistently superior performance of Alberta carriers, regardless of the group studied, over the performance of carriers in Quebec or Ontario. The point estimates of the overall differences in performance displayed in Table 31 indicate that Ontario carriers perform more poorly than Quebec carriers and that Ontario's LTL carriers are the least efficient relative to Alberta performance. The modification of the models to account for utilization, though controversial, does not change these conclusions. These results were insensitive to modifications in the makeup of the provincial samples and alternative segmentation criteria. Finally, the cost models were calibrated for the NGF carrier population. The economic and regulatory results differed from the GF carrier results as expected. These results are consistent with the results of both Maister, and McRae and Prescott with regard to the movement of fabricated materials and end products which are generally transported by general freight carriers. Specifically, McRae and Prescott observed that provincial rates on these products were highest in Ontario, next highest in Quebec (and British Columbia) and lower in Alberta (though still lower in Manitoba and Saskatchewan). Further, there is some evidence that several types of less-than-truckload rates are much higher than equivalent rates in use in other provinces.[1] However, this evidence is severely questioned.[2]

This study finds, however, that the higher revenues earned in Ontario and Quebec are needed to cover the higher resource costs incurred in producing their services. The issue that requires further exploration is, from what sources do these higher costs arise? The "monopoly wage" hypothesis is not relevant in this instance since wages were equalized or found to be insignificant in the comparisons. Differences in traffic mix (TL versus LTL or types of commodity) are minimized by concentrating on GF carriers. We are left with two plausible explanations: (1) the traffic patterns facing carriers in Ontario and Quebec are less amenable to efficient provision of trucking services than those facing Alberta carriers (these patterns include natural imbalances of traffic, density of freight flow, etc.); or (2) the differences in the regulatory environment may affect costs by reducing competitive incentives, reducing the flexibility of carriers through restrictive entry restrictions or encouraging the production of less efficient subsidized services. There is no reliable data on the traffic conditions facing the carriers in this study. We do observe that average utilization in Ontario exceeds the utilization rate in Alberta (see Table 23) and that differences in performance still exist after utilization effects are included in our models. Thus, if one believes that utilization of capacity is primarily a function of traffic and demand patterns, then we can attribute the remaining performance differences to the different regulatory environments. The differences in the regulations facing the study carriers are evident. Thus, we can certainly associate poor performance with the entry-regulated environments of Ontario and Quebec and superior performance with the unregulated environment of Alberta but we cannot be completely confident of the causal relationship between entry regulation and performance.

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[1] Ontario: Ministry of Transportation and Communications, Truck Transportation in the Province of Ontario: Phase 3: An Analysis of the Basic Rate Structures (Toronto, 1975), pp. 22-24.

[2] House, "Economic Regulation," p. 129.

Whether the reader prefers the first or the second explanation, several issues arise as to the usefulness of the research for policy purposes. In Chapter III, we recognized that the TOD data may be biased. In order to ascertain the nature and extent of potential bias we calculate and sum the carrier operating revenue for all of the study carriers in each of the study provinces from the MCF survey and then estimate comparable figures from the TOD survey. The ratio of total provincial revenues estimated from the TOD survey to total revenues calculated from the MCF survey was 80.4, 81.2 and 84.1 per cent for Quebec, Ontario and Alberta respectively. Thus, Quebec and Ontario revenues are underestimated 4.6 and 3.6 per cent more than Alberta revenues from the estimates of the TOD survey. We can reasonably assume that bias of the same magnitude exists for the estimate of output made in these statistical studies because the same individual weighting factor is common to both the estimate of output and of revenues. Consequently, Quebec and Ontario performance is understated relative to Alberta (or Alberta performance is overstated). However, it is easily seen that an increase of 3 to 5 per cent in the performance of Quebec and Ontario carriers will still leave the previous observations intact, given the magnitude of their relative inefficiency.

Another issue concerns how well the study carriers represent the Canadian trucking industry.[3] It was stressed in the development of the methodology that regulation varies with the class of commodities transported and by province. We can at least be assured that differences in economic regulation are controlled in the experimental design, by concentrating on intraprovincial, general freight carriers. The carrier population that we purport to represent in the analysis is therefore the general freight (GF), intraprovincial carrier segment of Canadian trucking in the three study provinces. Selected characteristics of the study carriers are compared against the same characteristics of all GF-intraprovincial carriers in Tables 52 to 54 for Quebec, Ontario and Alberta respectively. It is obvious that each study group includes a larger proportion of larger Class I carriers. Consequently, the total revenues earned

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[3] This issue was brought up at the January 17, 1980 meeting of the Trucking Working Committee for the Study of Competition and Regulation in Transportation (Ottawa). Discussion of this issue in this paper was subsequently suggested by the Committee.

TABLE 52

A Profile of the GF-Intraprovincial-Study Carriers and all GF-Intraprovincial Carriers in Quebec

	Carrier Group	
Profile Characteristic -- Mean	Intraprovincial-GF-Study Carriers	Intraprovincial -- all GF Carriers
Number of carriers[a]	51	208
% Class I[a]	25.5	7.7
% Class II[a]	35.3	26.0
% Class III[a]	39.2	66.3
Total revenue[a]	95 466 654	179 461 639
Revenue	1 871 895	862 796
No. of employees	74	36
% GF	95.4	96
Operating ratio	96.4	95.9
% Common carriers[a]	86.3	76.4
% Kilometres intercity	86.5	64.1
Transportation expenses[b]	57.6	64.5
Maintenance expenses[b]	12.6	10.9
Terminal expenses[b]	9.3	5.1
Traffic expenses[b]	1.5	0.8
Insurance & claim expenses[b]	3.9	4.1
Administrative expenses[b]	15.0	14.6
Purchased transportation[b]	2.8	3.0
Wage per employee	10 934	10 577
Fuel cost per litre ¢	16.1[c]	21.8

[a] Total.

[b] As a per cent of total expenses.

[c] Excludes one outlier whose fuel cost was reported as $13.20/L.

TABLE 53

A Profile of the GF-Intraprovincial-Study Carriers and all GF-Intraprovincial Carriers in Ontario

	Carrier Group	
Profile Characteristic -- Mean	Intraprovincial-GF-Study Carriers	Intraprovincial -- all GF Carriers
Number of carriers[a]	52	237
% Class I[a]	40.4	9.3
% Class II[a]	32.7	22.8
% Class III[a]	26.9	67.9
Total revenue[a]	143 221 920	223 932 006
Revenue	2 754 268	944 861
No. of employees	86	33
% GF	90.0	93.3
Operating ratio	96.4	94.9
% Common carriers[a]	76.9	73.8
% Kilometres intercity	86.1	72.3
Transportation expenses[b]	68.4	68.7
Maintenance expenses[b]	9.4	9.3
Terminal expenses[b]	5.8	4.0
Traffic expenses[b]	1.4	0.5
Insurance & claim expenses[b]	2.2	3.1
Administrative expenses[b]	12.8	14.4
Purchased transportation[b]	16.1	10.0
Wage per employee	13 072	11 517
Fuel cost per litre ¢	12.7[c]	14.6

[a] Total.

[b] As a per cent of total expenses.

[c] Excludes four carriers which didn't report fuel data.

TABLE 54

A Profile of the GF-Intraprovincial-Study Carriers and all GF-Intraprovincial Carriers in Alberta

	Carrier Group	
Profile Characteristic -- Mean	Intraprovincial-GF-Study Carriers	Intraprovincial -- all GF Carriers
Number of carriers[a]	28	82
% Class I[a]	0	0
% Class II[a]	32.1	15.9
% Class III[a]	67.9	84.1
Total revenue[a]	15 244 790	30 192 882
Revenue	544 457	368 206
No. of employees	17	13
% GF	97.3	97.0
Operating ratio	94.6	96.7
% Common carriers[a]	82.1	82.9
% Kilometres intercity	91.2	81.8
Transportation expenses[b]	63.8	67.5
Maintenance expenses[b]	10.4	8.2
Terminal expenses[b]	7.5	5.4
Traffic expenses[b]	0.2	0.2
Insurance & claim expenses[b]	3.4	3.1
Administrative expenses[b]	14.7	15.7
Purchased transportation[b]	8.8	13.6
Wage per employee	11 472	10 945
Fuel cost per litre ¢	17.3	15.2

[a] Total.

[b] As a per cent of total expenses.

by the study carriers account for over 50 per cent of the total revenues earned by all GF-intraprovincial carriers. Common carriers are overrepresented in the Quebec samples and the study carriers of all provinces have a greater percentage of intercity (nonurban) traffic. This is expected since the TOD survey sought to estimate intercity traffic characteristics, not urban traffic movements. Except for fuel costs in Quebec, none of the input prices or expense ratios appear to be significantly different between the study carriers and the parent population. We conclude that the business of the study carriers used in this study represents a significant proportion of the intraprovincial movement of general freight commodities and that any observations made about the study carriers may apply to the population.

A third issue arises over what wasn't analyzed. In the development of the research it was decided that too few observations existed in Manitoba and Saskatchewan to provide meaningful results. Consequently, we cannot confirm or disaffirm the recent McRae and Prescott findings of superior rate performance in Manitoba and Saskatchewan relative to Alberta.[4] Obviously this is an area that needs supplemental research. Policy implications can be made from these results if we can be reasonably assured that all of the relevant variables have been considered inside and outside of the modeling effort. Inside the model, we have hypothesized that performance is a function of a number of economic variables for which values were available. Quality of service factors such as frequency of service, availability of equipment, speed and safety are factors which could be statistically important, but have not been measured. More importantly, neither this analysis nor previous studies have been able to model successfully the demand environment in which carriers operate. Carriers facing temporal and geographic freight imbalances cannot possibly be as efficient as those who do not.

Outside of the model, we must ask whether different regulatory schemes are transferable. This question is of obvious importance given: (1) the results of this analysis which suggest that entry regulation without price control or with weak price control results in worse performance than no regulation altogether, and (2) the McRae-Prescott findings regarding strict entry and rate regulation. Is the solution for better performance to increase rate control or to eliminate all controls? The answer may hinge on administrative feasibility. Wilson, commenting on the United States experience, places the problem in perspective:

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[4] Effects of Regulation, p. 70.

> In the final analysis, economic regulation of freight transportation is a relative failure largely because of administrative infeasibility which has become progressively worse since the late 1920's with the sharp growth of the motor carrier. Economic and even social regulation of monopoly or oligopoly is possible and can be effective and desirable. However, the attempt to control as many as 16000 "regulated" firms...poses administrative problems of the first magnitude.[5]

In conclusion, this study has confirmed previous observations of the superior rate performance of carriers operating in the unregulated environment of Alberta vis-à-vis carriers operating in the entry-restricted environments of Ontario and Quebec. Further, the study finds that relative cost performance follows an identical pattern. There is no information available in this study to conclude whether the performance differences can be attributed to regulatory policies that can be controlled or to demand factors that are out of direct reach of public policy. One can unequivocally state that economic regulations differ between the provinces, while the extent of demand and traffic differences is largely unexplained. The inefficiencies of economic regulation are clearly large if policymakers perceive exogenous demand patterns to be equally burdensome between provinces or are more burdensome in Alberta. The fact that the measured utilization of capacity is higher in Ontario than Alberta, and that differences in performance are still observed in the models accounting for the impact of utilization, support this view.

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[5] G.W. Wilson, "Regulation, Public Policy and Efficient Provision of Freight Transportation," Transportation Journal 15, no. 1 (Fall 1975), p. 17.

Appendix A

A COMPARISON OF TWO POTENTIAL MEASURES OF TRUCKING OUTPUT

Two of the more popular measures of transportation output were available for use in this study. Tonne-kilometres and number of shipments are theoretically the same when the two dimensions of a shipment, the weight and shipment distance, are accounted for; that is, if the average weight and distance per shipment (or per tonne-kilometre) were held constant, an increase in tonne-kilometres would imply a proportionate increase in number of shipments. On a priori grounds, one would choose tonne-kilometres if it was felt that adequate measures of the shipment weight and distances were not available. On the other hand, number of shipments is subject to less measurement error. For the purpose of this research the measure of output that exhibits the greatest explanatory power in our models would be the practical choice. This is determined by calibrating two cost models which are identical except for the measure of output. The cost model employed included all of the potential explanatory variables defined in Table 4 except COM and R. The estimating equation is thus:

$$(A.1)\quad TCOST = a_0 + a_1\, WAGE + a_2\, FUEL + a_3\, CAP + b_1\, AWT + b_2\, AHAUL + b_3\, PLTL + b_4\, SH + C_0 O + c_{00} O^2$$

Equation A.1 was estimated for 270 intraprovincial, general freight carriers and the coefficient estimates are shown in Table A.1.

Overall, the regression results are quite similar. In terms of predictive power, both alternatives are practically identical, the "shipment" cost model being insignificantly more powerful. Coefficients for price variables are similar. The signs of the length of haul and weight of shipments variables all fulfill a priori expectations. For the shipment model, if AWT increases, the sign implies that a carrier transporting a given number of shipments will increase its costs because shipments are heavier and more tonne-kilometres are being moved. For the tonne-kilometre model, if AWT increases, this implies that a carrier transporting a given number of tonne-kilometres will decrease its costs because each tonne-kilometre is easier to produce as fewer but larger shipments are being transported. The estimate of optimal scale is 182 016 shipments and 196 667 800 t-km. The geometric mean average weight and length of haul are approximately 2.27 t and 281.6 km. The optimal scale in terms of shipments multiplied by these two figures yields an estimate of equivalent tonne-kilometres of 116 262.720.

TABLE A.1

Coefficient Estimates for Cost Model Utilizing Alternative Definitions of Output for General Freight Carriers

Variable	Model with	
	Shipments	Tonne-Kilometres
Constant	-4.9745	-0.5489
0	-0.6751 (0.0970)[a]	- .3299 (.0765)
0^2	0.0675 (0.0054)	.0563 (.0047)
WAGE	0.7101 (0.1669)	.8801 (.1695)
FUEL	-0.1225 (0.0792)	.0269 (.0812)
CAP	0.0929 (0.0505)	.0485 (.0511)
AWT	0.3946 (0.0421)	- .1340 (.0427)
AHAUL	0.1941 (0.0775)	- .3104 (.0839)
PLTL	0.1856 (0.0432)	.1162 (.0434)
SH	-0.0149 (0.0519)	.0223 (0.0523)
R^2	79.69	79.06
R^2 adjusted	78.98	78.23
N	270	270
F overall	113.32	109.06

[a] Standard errors in parentheses.

In summary, it appears that the use of tonne-kilometres or shipments as the measure of output makes very little difference quantitatively.[1] We choose number of shipments because it is a natural unit of output, it has a slight superiority in estimating GF carrier cost behaviour and because of the reasonable assumption that there is less measurement error in measuring number of shipments than tonne-kilometres (which is a function of each shipment sampled, weight and distance).

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1. This conclusion is only applicable to the data source utilized in this research, the TOD survey. In the United States, tonne-kilometres is definitely inferior to number of shipments as a measure of output because it is generally estimated by most carriers from aggregate data rather than built up from individual records.

Appendix B

TEST OF THE HOMOGENEITY OF TWO REGRESSION LINES

In economic and business analysis we frequently wish to examine the similarities and differences between two or more populations represented by two or more regression lines. A comparison of the two regression lines may be desired to obtain information as to the nature of the differences, if any, between them. Specifically, the slopes of the regression lines may be similar or the intercepts may be similar or both. Another reason for interest in comparing two regression lines is to determine whether they can be pooled. A single pooled regression would have the advantage of containing greater precision than two different regressions as well as yield an overall estimate of the difference between the two regression lines when the intercepts are significantly different but the slopes are homogeneous.

Neter and Wasserman[1] suggest that a general linear test (GLT) of the equality of two regression lines would employ the test statistics:

$$(\text{B.1})\quad F = \frac{SSE(R)-SSE(F)}{df_R - df_F} \div \frac{SSE(F)}{df_F}$$

where SSE(R) is the error sum of the squares for the single reduced model that assumes that two regression lines are identical. SSE(F) is the error sum of the squares for the full model that assumes the two regression lines are not identical. This equals the total SSE of the separate regressions. df_R is the degrees of freedom for the reduced model and df_F is the degrees of freedom for the full model. If F exceeds $F^*(1-d;\ df_R - df_F,\ df_F)$ then one would conclude that the two linear regressions are not the same.

A more comprehensive test of homogeneity is suggested by Johnston.[2] A complete analysis of covariance table is constructed as illustrated in Table B.1.

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[1] J. Neter and W. Wasserman, Applied Linear Statistical Models (Homewood, Ill.: Richard D. Irwin Inc., 1974), pp. 87-89, 160-67.

[2] J. Johnston, Econometric Methods (New York: McGraw-Hill, 1972), pp. 192-203.

The residual sum of squares (SS_R) is computed from the reduced model that assumes two (or more) regression lines are identical. SS_4 is the error sum of the squares of the full model. Thus it equals the summation of the separate sum of squares for each separately estimated regression. SS_2 is the sum of squares of the pooled model using a dummy or indicator variable to distinguish between the two samples. SS_3 is the difference between SS_2 and SS_4, and similarly SS_1 is the difference between SS_R and SS_2.

The test of the homogeneity of regression (slopes and intercepts) between regressions is then achieved by contrasting the reduction in the residual sum of the squares from SS_R to SS_4. The test of overall homogeneity is:

$$\text{(B.2)} \quad F_3 = \frac{(SS_1 + SS_3)/(df_1 + df_3)}{SS_4/df_4}$$

This is equivalent to B.1 in the GLT.

TABLE B.1

Analysis of Covariance Table

Sum of squares (SS)	df	Mean Square (MSE)
SS_4		
$SS_3 = SS_2 - SS_4$		
SS_2		
$SS_1 = SS_R - SS_2$		
SS residual = SS_R		

The test of the homogeneity of vectors of slope coefficients is based on the reduction in the residual sum of the squares from SS_2 to SS_4. The test of differential slope vectors is:

(B.3) $$F_2 = \frac{MSE_3}{MSE_4}$$

If we cannot reject the hypothesis of a common regression slope, the test for differential intercepts is found by comparing the reduction in the residual sum of squares from SS_2 to SS_R. The test of differential intercepts is:

(B.4) $$F_1 = \frac{MSE_1}{MSE_2}$$

In this study, these tests can be used for two purposes. First, the GLT can be used to test hypotheses regarding the heterogeneity between segments of the trucking industry. A significantly large F statistic (B1) would suggest that the two regression lines represent two different populations. Keeler, for example, applies this test to analyze the difference between rail-truck elasticity of demand in Australia and the United States.[3] Second, the complete analysis of covariance test will determine whether we are justified in pooling similar types of carriers from different provinces into a single estimate. This would allow us to utilize dummy or indicator variables which would yield an overall point estimate of the differences in performance between two provinces.

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[3] T. Keeler, "Regulation and Modal Market Shares in Long Haul Freight Transport: A Statistical Comparison of Australia and the United States," in H. Whitten, ed., Foreign Regulatory Experiments: Implications for U.S. (Washington, D.C.: U.S. Department of Transportation), pp. 9.37-9.48.

Appendix C

ECONOMIC FACTORS INFLUENCING CAPACITY UTILIZATION

The influence of traffic mix on capacity utilization in this study was minimized by the selection of general freight (GF) carriers and the inclusion of shipment size and length of haul variables in the model. Traffic demand factors such as seasonality of the available traffic, the volume of freight available on the carriers' routes and the balance of that freight flow were not explicitly considered. Both the unavailability of data and methodological problems make such consideration difficult. Specifically, it is not possible to link traffic flow data of the appropriate commodity type with the route structures of the individual GF carriers.

An overall measure of freight balance between major population centres and the rest of the respective province can be calculated. Intraprovincial traffic flows from major population centers to the rest of the province (outbound freight) and from the rest of the province to the population centre (inbound freight) are available from For-Hire Trucking Survey -- 1975. These flows are summarized for population centres in Alberta, Ontario and Quebec in Table C.1. In Table C.2, the balance ratio for each major population centre is computed. Each ratio is weighted by its relative importance in the province and summed to estimate an overall figure for the province. The computed ratios indicate that greater freight imbalances exist in Alberta than in Quebec or Ontario with respect to tonnage. With respect to tonne-kilometres, Alberta is faced with greater imbalance only when compared to Quebec. The increase in the tonne-kilometre imbalance observation for Ontario is due to the divergence between the length of haul of inbound versus outbound tonnage.

This data suggests that the Alberta intraprovincial motor carrier industry faces greater natural constraints against full vehicle utilization than do the comparable industries in Ontario and Quebec. Of course, individual carriers may achieve very high utilization at the expense of other carriers. Finally, we note that such conclusions do not apply to the intraprovincial carriers studied in the body of the paper. The data analyzed in this appendix does not represent flows of general freight commodities which may be more or less balanced than the flow of all traffic.

TABLE C.1

Intraprovincial Freight Flow between Major Population Centres and Province

	Direction of Traffic Flow	Revenue (000's)	Tonnes (000's)	Tonne-Kilometres (000's)
ALBERTA				
Edmonton	O	44 330	2 291	627 888
	I	14 821	971	278 593
Calgary	O	21 621	1 249	293 829
	I	13 525	1 148	264 698
Total			5 659	1 465 008
QUEBEC				
Chicoutimi	O	3 644	210	61 206
	I	14 540	739	255 963
Quebec	O	25 710	1 202	308 834
	I	24 113	824	217 400
Montreal	O	104 336	5 909	1 449 460
	I	51 098	6 664	1 362 811
Ottawa-Hull	O	5 047	337	75 933
	I	14 913	720	182 646
Total			16 605	3 914 253

ONTARIO				
Ottawa-Hull	O	8 161	925	275 013
	I	20 003	537	226 776
St. Catharines	O	13 332	969	146 815
	I	13 683	1 674	649 623
Toronto	O	176 844	11 384	2 026 701
	I	106 383	12 169	1 699 741
Hamilton	O	33 592	3 614	534 211
	I	27 675	3 812	404 600
Kitchener	O	11 729	505	68 350
	I	12 658	873	106 517
London	O	22 072	1 415	221 716
	I	24 033	1 823	333 609
Windsor	O	13 807	674	180 881
	I	25 563	1 809	538 844
Sudbury	O	8 106	320	113 001
	I	13 142	663	199 642
Thunder Bay	O	5 503	246	145 672
	I	18 622	1 214	420 633
Total			44 627	8 292 343

Source: Statistics Canada, For-Hire Trucking Survey -- 1975, cat. no. 53-224, 1977, Tables 4 and 5.

Key: O -- outbound to rest of province.
I -- inbound from rest of province.

TABLE C.2

Intraprovincial Freight Flow Balance Ratios between Major Population Centres and Province

	Tonnes				Tonne-Kilometres	
	Ratio	Weighting Factor	Weighted Ratio	Ratio[a]	Weighting Factor	Weighted Ratio
ALBERTA						
Edmonton	2.36	.5764	1.36	2.25	.6188	1.39
Calgary	1.09	.4236	.46	1.11	.3812	.42
Total			1.82			1.82
QUEBEC						
Chicoutimi	3.53[b] (.28)	.0569	.20	4.18[b] (.24)	.0810	.34
Quebec	1.49	.1229	.18	1.42	.1344	.19
Montreal	1.13[b] (.88)	.7567	.86	1.06	.7185	.76
Ottawa-Hull	2.13[b] (.47)	.0634	.13	2.41[b] (.42)	.0661	.16
Total			1.37			1.45
ONTARIO						
Ottawa-Hull	1.72	.0328	.06	1.21	.0605	.97
St.Catharines	1.73[b] (.58)	.0592	.10	4.42[b] (.23)	.0960	.42
Toronto	1.07[b] (.94)	.5278	.56	1.19	.4494	.53
Hamilton	1.05[b] (.95)	.1664	.17	1.32	.1132	.15
Kitchener	1.73[b] (.58)	.0309	.05	1.55[b] (.64)	.0211	.03
London	1.28[b] (.78)	.0726	.09	1.50[b] (.66)	.0670	.10
Windsor	1.69[b] (.37)	.0556	.15	2.98[b] (.34)	.0868	.26
Sudbury	2.07[b] (.48)	.0220	.05	1.77[b] (.57)	.0377	.07
Thunder Bay	4.94[b] (.20)	.0327	.16	2.88[b] (.35)	.0683	.20
Total			1.40			1.83

[a] Ratio of outbound to inbound if O > I, or ratio of inbound to outbound if I > O.
[b] I > O.